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South Staffs Water

Company Headroom Analysis

Water Resource Management Plan 2019

31 October 2018

South Staffs Water

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Executive summary

This document summarises the target headroom assessment carried out for the Company Water Resource Zone, forming part of the South Staffs Water WRMP19 planning process.

Target Headroom is defined as the minimum buffer that a prudent water utility should introduce into the annual supply-demand balance to ensure that the Water Utility's chosen level of service can be achieved. Target Headroom is calculated according to a standard methodology developed and published by UKWIR (An Improved Methodology for Assessing Headroom, UKWIR, 2002). All components of target headroom uncertainty have been assessed and reviewed by South Staffs Water, with time series of uncertainty distributions defined from 2018 to 2045 for each component, reflective of dry year annual average (DYAA) and dry year critical period (DYCP) conditions.

The distributions were uploaded into a tailor-made spreadsheet headroom model using @Risk Monte Carlo analysis. 10,000 iterations of the model were run to determine a comprehensive percentile distribution of headroom time series for both DYAA and DYCP conditions. A risk profile was selected in line with the WRMP guidelines and used to output target headroom values for supply demand balance modelling of the Water Resource Zone.

DYAA Target headroom starts at 7.0 Ml/d in 2018, increasing steadily along the 95th percentile profile to a maximum of 9.9 Ml/d in 2030. The increase in risk acceptance beyond 2030 means that target headroom decreases slowly thereafter to 7.8 Ml/d by 2045. DYCP Target headroom starts at 11.6 Ml/d in 2018, increasing steadily along the 95th percentile profile to a maximum of 13.7 Ml/d in 2030. The increase in risk acceptance beyond 2030 means that target headroom fluctuates slightly thereafter, finishing at 12.8 Ml/d by 2045.

1 Introduction and background

Water Companies in England and Wales have a statutory duty to prepare and submit Water Resources Management Plans (WRMP), including Supply Demand Balance (SDB), to the Environment Agency (EA) and Ofwat. A key component of these WRMPs is Target Headroom.

Target Headroom is defined as the minimum buffer that a prudent water utility should introduce into the annual supply-demand balance to ensure that the Water Utility's chosen level of service can be achieved. Target Headroom is calculated according to a standard methodology developed and published by UKWIR (An Improved Methodology for Assessing Headroom, UKWIR, 2002).

Mott MacDonald (MM) has been engaged by South Staffordshire Water to assess Target Headroom for the 2017 Draft WRMP.

1.1 Objectives and scope of work

The objectives of the project are:

- to review and analyse data provided by South Staffordshire Water, to evaluate uncertainty in headroom components and produce appropriate probability distributions for each component; and
- to assess South Staffordshire Water's Target Headroom under average and peak conditions.

In addition, the scope of work includes the actions below:

1. Update the analysis for uncertainty of impacts of climate change on demand;
2. Review the uncertainty in deployable output associated with changing nitrate concentration and make recommendation for an appropriate headroom allowance
3. Produce summaries of the headroom results by component;
4. Produce a report outlining the methodology and assumptions used and presenting the results of the analysis.

1.2 Background to Target Headroom

1.2.1 Why assess Target Headroom

A variety of components of the supply/demand balance are subject to uncertainty, both their present values and forecast future trends.

It is therefore important that water companies make sufficient allowance in their water resource planning for such uncertainty to ensure that, for each resource zone, the risk of a supply-demand deficit in critical periods is eliminated or reduced to an acceptable level. This is done by calculating and incorporating in the supply-demand balance a target headroom allowance.

Water companies must show evidence that they have taken this into account when they submit their WRMPs as part of the periodic review process. The last WRMPs were submitted to the Environment Agency in 2014 and 2015 and these also formed the companies' supply-demand balance submissions to the Office of Water Services (Ofwat) as part of PR14. These plans take a long-term view and demonstrate how the company intends to maintain an acceptable balance of supply and demand into the future. The last plans considered the planning period 2012 to 2040 whilst the PR19 planning period will cover the years 2017 to 2045.

1.2.2 Headroom in the Supply Demand Balance and Accepted Definitions

The Supply Demand Balance is calculated as the difference between Water Available for Use (including imported water if applicable) and demand at any given point in time by comparing deployable output (D.O.) with water demand, after allowing for outage and target headroom.

In assessing the supply demand balance, the following equations are normally adopted:

1. Water Available for Use (WAFU) = Deployable Output (DO) – Outage
2. Available Headroom = WAFU – demand
3. Available Headroom ≥ Target Headroom needed to satisfy given standards of service

Definitions for the terms used in the equations are given in Box 1 below. These are taken from the Environment Agency Water Resources Planning Guidelines (2012), and may vary slightly from other references. No change to definition is presented in the 2016 guidelines.

Table 1: Definitions

Quantity	Definition
Water Available for Use	The value calculated by deducting allowable outages and planning allowances from deployable output in a resource zone
Available Headroom	The difference (in Ml/d or percent) between water available for use (including imported water) and demand at any given point in time
Target Headroom	A buffer between supply and demand designed to cater for specified uncertainties.

Source: EA Water Resource Planning Guidelines, June 2012

Deployable Output is generally considered to be the output of a source allowing for all constraints, whether physical, licence or environmental, for a given level of service. As such it is the volume of water that can be deployed into supply. Outage is defined at its simplest as a temporary loss of deployable output.

Target Headroom is defined as the minimum buffer that a prudent water utility should introduce into the annual supply-demand balance to ensure that the water utility's chosen level of service can be achieved. It is the margin between water available for use (WAFU) and demand required for planning purposes to cater for uncertainties (except for those due to outages) in the overall supply-demand balance.

Available Headroom is defined as the margin between Water Available for Use (WAFU) and demand at a given point in time and in theory is a measurable quantity of water. Target Headroom is a derived value which represents the minimum acceptable Headroom required for planning purposes to cater for uncertainties (excluding outages) in the overall supply-demand balance.

The issue of headroom came to prominence as a result of the 1995/96 Yorkshire drought where the independent commission of inquiry chaired by Professor Uff concluded that the Yorkshire Water supply system had an insufficient margin of resource over demand. This led to the concept of headroom uncertainty being introduced in the Environment Agency (EA) 1997 Water Resources Planning Guideline and the United Kingdom Water Industry Research (UKWIR) project that developed the 1998 Headroom Methodology. In 2002, UKWIR issued an improved risk based methodology for assessing headroom uncertainty (the 2002 UKWIR Headroom Methodology) which has been widely adopted and is considered to be the “best practice” methodology.

1.3 Environment Agency Water Resources Planning Guidance

The Environment Agency issued in May 2016 the Water Resource Planning Guidelines for the 2018 Water Resource Plans. The report states the following.

You may assess individual components of uncertainty and variability using risk-based planning techniques, through your decision-making tool or assess uncertainty separately from individual components using the target headroom approach. The following documents set out different approaches to assessing uncertainty:

- *UKWIR (2016) WRMP19 Methods – Risk Based Planning*
- *UKWIR (2016) WRMP19 Methods – Decision Making Process*
- *UKWIR (2002) An Improved Methodology for Assessing Headroom*
- *UKWIR (1998) A Practical Method for Converting Uncertainty into Headroom*

If you use the older target headroom guidance you should justify why it is appropriate.

If you use risk-based planning tools or a decision-making tool to assess uncertainty and variability you may not need to calculate target headroom, or you may need to exclude some target headroom components. If so, you will need to explain the methods and assumptions you have used and demonstrate that you have not double counted or omitted uncertainties.

If you use target headroom to provide a buffer for uncertainties, you need to consider the appropriate level of risk for your plan. If target headroom is too large it may drive unnecessary expenditure, if too little you may be unable to meet your planned level of service. You should also accept a higher level of risk further into future than in the early years (first 5 years) because as time progresses the uncertainties for which headroom allows will reduce and you will be able to adapt to any changes.

You should provide a clear justification of the assumptions and information used to assess your uncertainties. You should assess the relative contributions clearly showing which uncertainties have the biggest impact in each WRZ. You should communicate this in a clear manner for customers and interested parties to understand easily. You should consider options for reducing uncertainty during the planning period.

South Staffs Water has opted to use the 2002 UKWIR Headroom Methodology for target headroom to assess uncertainty in its South Staffs zone, rather than using risk-based planning or decision-making tools, so there is no risk of double counting uncertainties.

2 Methodology

The methodology for this headroom analysis follows the best practice guidance set out in the 2002 UKWIR "Improved Methodology for Assessing Headroom". It builds on the headroom analysis models used by South Staffs Water to calculate their target headroom for previous WRMPs.

2.1 Overview

In 2002, UKWIR published its improved methodology for the calculation of headroom allowances. This advocates the use of a probabilistic approach, based on Monte Carlo analysis. The analysis involves defining probability distributions for magnitude of headroom components and combining these to give an overall probability distribution for the target headroom allowance. A "lotus notes"-based spreadsheet with an add-in Monte Carlo analysis tool called @RISK was produced as part of the project.

2.2 Components of Headroom Uncertainty

The 2002 UKWIR methodology Headroom is divided into the following supply side and demand side components:

Table 2: Supply and Demand Side Headroom Categories

Supply Side Headroom Categories	Demand Side Headroom Categories
S1 – Vulnerable surface water licences	D1 – Accuracy of sub-component data
S2 – Vulnerable groundwater licences	D2 – Demand forecast variation
S3 – Time limited licences	D3 – Uncertainty of climate change on demand
S4 – Bulk transfers	D4 – Uncertainty of demand management solutions
S5 – Gradual pollution causing a reduction in abstraction	
S6 – Accuracy of supply side data	
S8 – Uncertainty of climate change on yield	
S9 – Uncertain output of new resource developments	

Source: UKWIR

The 2002 UKWIR methodology removed issue S7 (single source dominance and critical periods) as it was considered to be an outage issue and already included in the supply demand balance. The following two headroom components were added:

- S9 Uncertain output of new resource developments
- D4 Uncertain outcome of demand management measures

Each of the above components has been considered by South Staffordshire Water for its Company water resource zone and the headroom uncertainty issues associated with each component have been identified. For some of the components listed above, more than one issue has been included.

2.2.1 Supply Side Components

S1-S3 (vulnerable licences): Uncertainty over future reductions in abstraction licensing have been updated to include the latest deployable output and abstraction licence values (S1-S3 are only used for sensitivity analysis and are not included in target headroom).

An allowance for S4, bulk transfers, has been introduced at PR19, after better understanding of the uncertainty in company bulk exports.

S5, gradual pollution of groundwater sources, is applied to allow for uncertainty associated with deterioration, rehabilitation and replacement of boreholes, uncertainty in future long-term trends in nitrate pollution, and uncertainty over coalfield mine water pollution at Moors Gorse. Temporary losses of DO relating to these factors are quantified and accounted for in the Outage allowance.

S6 comprises uncertainty in the accuracy of supply-side data. For every groundwater source, the constraining factor for DO is identified: abstraction licence, infrastructure, pumping water level (potential yield), treatment capacity or water quality. For abstraction licences, the uncertainty relates to meter reading reliability. To avoid double-counting, only meters measuring abstraction separately to distribution input are included here. Infrastructure constraints carry uncertainty in pump outputs, yield constraints are subject to a number of uncertainties in the "source reliable output" method, but no such sources exist for South Staffs. There are uncertainties in a number of treatment processes, and water quality can limit deployable output subject to uncertainty in existing conditions (primarily sand ingress here). Trend uncertainty is covered under S5. Surface water yield uncertainty is due to imperfect climate and hydrological historical data records and variability in surface water yield models.

Uncertainty of climate change on source yield (S8), is quantified using Aquator modelling of climate change scenarios on the DO of surface water sources. No groundwater sources are constrained by potential yield, such that there is no risk of climate change impacting groundwater source yield.

No new options are planned for completion in the near future, such that in S9, only final preferred options need be considered. These should not feature in baseline target headroom, but uncertainty in their output could be determined as necessary for any options selected in the final preferred balance.

Supply side components have been updated to include the latest deployable output values reviewed for the draft WRMP.

Sign convention for supply-side headroom follows that of UKWIR 2002, that is:

- Data uncertainty that leads to a loss of *Deployable Output* = negative Headroom
- Data uncertainty that leads to an increase in *Demand* = positive Headroom

2.2.2 Demand Side Components

D1 accounts for uncertainty in the accuracy of sub-component data. As for S6, this reflects the reliability of meter readings, which could impact the accuracy of the demand forecast. To avoid double-counting, only meters measuring distribution input separately to abstraction are included here.

D2 comprises uncertainty in population growth, change in size of households, measured and unmeasured consumption, non-household consumption, dry-year correction, and peak period adjustment. These are input as time series of % uncertainty to the model.

D3, uncertainty of impact of climate change on demand has been determined according to the UKWIR methodology, Impact of Climate Change on Water Demand (2013), with time series of % uncertainty applied to household consumption.

D4, uncertainty of demand management solutions, has not been included in baseline target headroom. Should demand management solutions be required to maintain the supply demand balance to 2045, an allowance will be made in final preferred target headroom for D4.

Sign convention for demand-side headroom follows that of UKWIR 2002, that is:

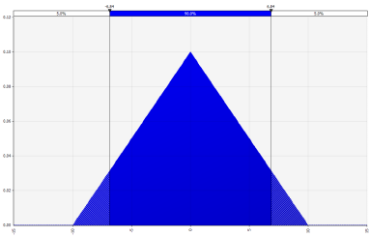
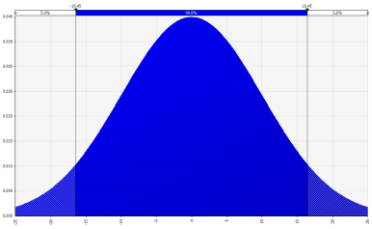
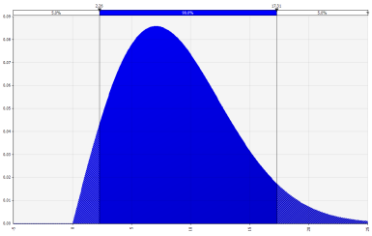
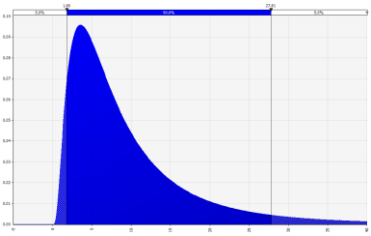
- Data uncertainty that leads to a decrease in De*mand* = negative Headroom
- Data uncertainty that leads to an increase in *Demand* = positive Headroom

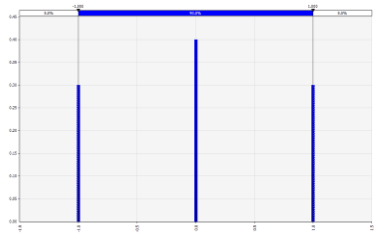
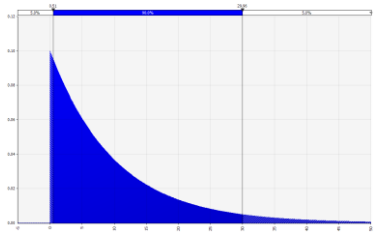
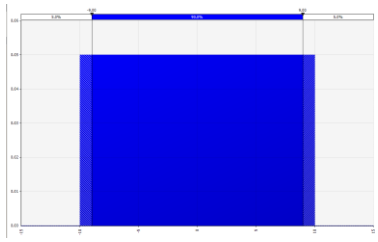
Each of the components of headroom is described in more detail in the following sections.

2.3 Probability Distributions and Monte Carlo Simulation

For each issue, a probability distribution has been developed that quantifies the extent of the uncertainty. A variety of distributions is available within the methodology, with triangular distribution being the most commonly used. Distributions have been used depending upon the individual circumstances with examples presented in Table 3.

Table 3: The Types of Probability Distribution that can be used for Headroom Analysis

Type	Shape	Description	Application
Triangular		Most easily defined continuous distribution. Defined by a least likely, most likely & maximum likely value. Can be skewed either way.	Situations where the value can be any value within a range and the most likely value can be estimated. Widely applicable, though may not be appropriate if highly skewed.
Normal		Symmetrical continuous distribution defined by a mean and standard deviation.	Most commonly applied situations where the probability of the extreme values of the distribution would artificially increase if using a triangular distribution.
Weibull		Continuous distribution.	Difficult to define but could be fitted to a data set within the software.
Log-normal		Skewed continuous distribution defined by a mean and standard deviation.	Situations where there is a large difference between the maximum and the most likely values such that a triangular distribution is considered unsuitable.

Type	Shape	Description	Application
Discrete		Non-continuous distribution defined by values and probabilities.	Situations where specific values apply and values in between do not.
Exponential		Continuous distribution.	Suitable for extreme events but with the introduction of cut-offs. Difficult to define but could be fitted to a data set within the software.
Fixed		Continuous distribution defined by a single value.	Situations where only one value applies. Essentially not a distribution but given as an option within the software.

The Monte Carlo simulation combines each of the individual component distributions to produce an overall distribution of headroom uncertainty. This is achieved by running a large number of trials (or iterations). In each trial values are randomly selected from within the component distributions and summed to give an overall headroom value for the trial. After a large number of trials (ten thousand has been used in this analysis) a distribution of headroom values results. To take account of changing uncertainty throughout the planning period the analysis has been repeated on an annual basis between 2017/18 to 2044/45. Key issues identified during the analysis, together with the results are presented below for each resource zone.

2.3.1 Software and simulations

Various software packages are available for performing Monte Carlo analysis. This methodology has been tested using @RISK, an add-in software package which operates within a spreadsheet environment. When a Monte Carlo simulation is run, the software randomly selects numbers from the probability distribution assigned to each component of target headroom. Each set of random numbers effectively simulates a single 'what-if' scenario for the spreadsheet model. As the simulation runs, the model is recalculated for each scenario and the results are presented as a series of forecast charts for Headroom Uncertainty.

The simulation stops according to criteria set by the user, which is normally a number of iterations or trials. The number of trials must be set to give an acceptable mean standard error for the simulation results, whilst controlling the processing time to workable limits. A typical number of trials might be 1,000 to 10,000.

3 Headroom Components

The South Staffs Water headroom model has been developed following the best-practice UKWIR methodology, and builds on previous iterations used for WRMP14 and WRMP09.

3.1 Supply Components

3.1.1 S1.1 Vulnerable Surface Water Licences

Headroom uncertainty associated with vulnerable surface water licences arises from concerns over the sustainability of abstractions at the licensed rates and the likelihood that licences may be modified (reduced). Where appropriate, this has been considered under scenario modelling for the draft plan.

3.1.2 S2.1 Vulnerable Groundwater Licences

The EA has an aspiration to reduce groundwater abstraction licences in many catchments as part of their Restoring Sustainable Abstraction Programme. For many catchments the licence clawback has now been quantified through the CAMS process, and this has resulted in a significantly lower licensable resource (with much greater potential licence reductions). The driver in future for clawing back licences will be the Water Framework Directive, however there are no quantitative numbers available yet. This has been considered under scenario modelling for the draft plan.

3.1.3 S3.1 Time-limited Licences

The Company has three time-limited licences:

Table 4: Time-limited licence quantities and dates

Licence	Time Limited Quantity (Annual Average Ml/d)	Time Limit Date
River Severn (18/54/2/584/S)	11	31st March 2034
3/28/6/84/S and 3/28/6/99/S	50	30th March 2018
Blakedown 3 (18/54/6/140/G)	2 (0)	31st March 2021

Part of the River Severn licence (No. 584) is time limited to 2034 (11 Ml/d). This abstraction is from the River Severn. The River Blithe licence is scheduled to alter abstracted volumes in 2018, however new licenced volumes will still exceed infrastructure capacity. This means the licence change after 2018 has no impact on peak transfer capacities. However, the deployable output is strongly linked to a clause allowing use of the River Trent licence to maintain River Blithe flows above the Hands-Off Flow for the River Blithe.

Abstraction from the Blakedown 3 borehole is for the purpose of augmenting water levels in the nearby pools and rivers and is neither used for public water supply nor affects the operation of other boreholes

Overall, no allowance for time-limited licence is to be made in headroom. These are all to be assessed in scenarios.

3.1.4 S4 Bulk Supplies

The Company operates around 30 potable water connections at the boundaries of its supply area which together constitute a net export of potable water. The majority of these are small in nature and are known collectively as the Minor Exports. There is a much larger export to Severn Trent Water in the Wolverhampton area which arises from the joint ownership by South Staffs Water and Severn Trent Work of the River Severn abstraction.

The capacity of Minor Exports is up to 5 Ml/d but average usage has been consistently around 1 Ml/d and is largely independent of seasonal demands. Nevertheless, volumes have increased on occasion to 2 Ml/d during the peak demand months. As a consequence, a positive headroom value of 1 Ml/d is specified.

The contractual entitlement for the Wolverhampton Export is 40.6 Ml/d at average and 48 Ml/d at peak and has been adopted for the Company's deployable output calculations. Whilst the peak capacity is proven and has been assumed by Severn Trent Water in its planning assumptions, the annual average volume is not taken and Severn Trent have indicated that their modelling assumptions only allow for 36 Ml/d. However, it has been agreed with the Environment Agency that 40.6 Ml/d should be assumed by both companies for planning purposes, with no allowance for uncertainty in headroom.

Table 5: SSW Bulk Supply Agreements and Uncertainty

	Annual Average (Ml/d)	Peak Week (Ml/d)		Minimum Uncertainty (Ml/d)	Maximum Uncertainty (Ml/d)
Minor Exports	1.0	1.0	Triangular	Avg 0.0 Peak 0.0	Avg 0.0 Peak +1.0

3.1.5 S5 Gradual Groundwater Pollution

The effects of a gradual or sudden pollution event can have a significant impact on deployable output. Where this results in a long-term loss of deployable output then this should be included in headroom. Three areas of uncertainty have been identified by South Staffs Water under this category.

3.1.5.1 Physical Deterioration of Boreholes

The asset condition and performance of each borehole has been regularly undertaken since PR09. This assessment has underpinned significant increases in investment under asset maintenance in the Company's groundwater sites. The average age of the Company's boreholes is more than 75 years and without this investment, significant borehole failures are likely, resulting in a reduction in deployable output. Whilst it is assumed that sufficient capital maintenance work will be funded and carried out to maintain stable serviceability, experience has shown that losses in deployable output arise in two ways:

- Asset performance, as measured by water quality (sand and turbidity), will decline to such an extent that outputs are cut back. Whilst short term reductions in output are accounted for in the Company's outage allowance, a significant reduction in permanent output may be incurred for a number of years pending site enabling works. Moreover, when re-drilling is required, there may be further delays for the drilling, testing and licencing process; and also, the requirement to construct new pump houses and connecting pipelines to existing treatment and network.

• Where remedial or replacement work is undertaken, there is a risk that yields will be lower or water quality may be different, with a resulting impact on deployable output.

Factors, Likelihood and Magnitude

The available evidence at SSW suggests that physical deterioration of boreholes can be divided into three main categories, and each remedial option is associated with some risk.

1. Deterioration of solid casing causing ingress of poor quality water. Subsequent relining can cause additional drawdown and a reduction in yield, or relining may not be practical causing a reduction in source output if the borehole is filled

2. Chemical and/or biological encrustation & clogging of slotted casing and open-hole sections, causing increased drawdown or water quality problems, with potential loss of yield. Chemical or mechanical treatment may cause deterioration in raw water quality.

3. Collapse and/or erosion of sandstone borehole walls, causing turbidity and requiring a drop in pumping rate, with potential loss of yield. Re-drilling or relining can cause additional drawdown and a reduction in yield. Re-drilling can however allow an increase in yield, particularly at peak.

The following assumptions have been used in evaluating the risk from borehole works in headroom:

- The maximum groundwater deployable output that currently could be affected is 140 Ml/d (80% of peak total groundwater D.O.).
- When each source is relined or replaced, there is a 10% chance that the yield will be reduced by 10%.
- When the borehole is replaced, there is a 5% chance that peak DO is increased by 20%.
- Over the first 20 years this represents a 10% chance of a total loss of 14 Ml/d offset by a 5% chance of a total increase of 28 Ml/d (peak). This level of investment and hence risk is assumed to continue over the remainder of the planning period.

The following discrete distribution was applied for each year for both annual average and peak week:

Table 6: Physical Deterioration of Boreholes: Headroom distributions

	Average	Peak
Minimum Loss	-1.4 Ml/d	0 Ml/d
Median Loss	0 Ml/d	0 Ml/d
Maximum Loss	0.67 Ml/d	0.7 Ml/d
Probability 1	5%	
Probability 2	85%	90%
Probability 3	10%	10%

3.1.5.2 S5/2 Nitrate, Pesticide and Solvent contamination

From the point of view of headroom, uncertainty in future long-term trends in nitrate and other groundwater contaminants has the potential to impact D.O. through a need for additional treatment and associated losses. Any output failures due to short term or seasonal peaks in nitrate are captured in company outage allowance.

Based on nitrate trends, the Company has identified a risk that some sources and existing blends (e.g. ASPW, CHPW1 and KIPW1) may exceed the nitrate limit during and after AMP7. The potential D.O. loss is based on the following assumptions.

Only a small proportion of the output of each station would be treated to a sufficiently low nitrate level to allow this to blend with the remainder of the source output, to bring the overall nitrate level below the required standard. There will be 2% losses associated with the treated component.

A triangular distribution has been applied to both annual average and peak week headroom, as the treatment plant would treat the same amount of water under both scenarios. The risk increases incrementally over time.

Table 7: Nitrate and other groundwater contamination: annual increases in headroom components from 2020

	Average	Peak Week
Minimum Loss	0 Ml/d	0 Ml/d
Most Likely	0.05 Ml/d	0.1 Ml/d
Maximum Loss	0.15 Ml/d	0.25 Ml/d

The uncertainty around nitrate treatment has been added with a starting point of 2020 in the headroom model.

3.1.5.3 S5/3 Mine waters

Available evidence suggests that there is a small risk that the Moors Gorse groundwater source could be contaminated by rising mine water, following the cessation of remedial pumping from the underlying coalfield.

Factors, Likelihood and Magnitude

Following the review of groundwater deployable outputs for the FWRMP, the dry year deployable output of Moors Gorse for the purposes of the headroom model is 2.7 Ml/d at average and peak based on likely NEP outcomes. A discrete distribution has been applied to these values, which assumes a small probability (5%) that the total deployable output from the source will be lost.

Table 8: Mine water headroom distributions

	For annual average		For peak week	
	Volume Ml/d	Probability	Volume Ml/d	Probability
Minimum Loss	0	95%	0	95%
Maximum Loss	2.7	5%	2.7	5%

3.1.6 S6 Accuracy of Supply-side Data: Groundwater

Data inaccuracy or lack of information can be a significant source of uncertainty around the calculation of deployable output. We have examined the constraining factors which define the Company's deployable output figures and assessed the range of uncertainty around each of these.

3.1.6.1 Abstraction Licence Constraints

The table below summarises the groundwater source deployable outputs that are constrained by abstraction licence, and whether the source has separate abstraction and distribution input meters. Where there are separate meters then the potential metering error has been estimated and is used as a measure of the uncertainty in the deployable output figures.

A figure of +/-2% is assumed for metering uncertainty. Where the abstraction meter and the distribution input meter are one and the same, then no uncertainty is attributed to the deployable output as this uncertainty would be double counted in the demand components of headroom.

Table 9: Abstraction licence-constrained sources: D.O. and meter uncertainty status

Source	Dry Year Deployable Output affected Ml/d	Peak Week Deployable Output affected Ml/d	Separate abstraction and distribution input meter
SLPW	5	5	No
MGPW	2.7	2.7	No
SEPW	5	N/A	No
MBPW	8.5	N/A	No
ASPW	18	N/A	No
COPW	15	N/A	No
PRPW	20	N/A	No
MAPW1	0.5	N/A	No
SHPW	0	N/A	Yes
SOPW	0	N/A	No
LHPW1	5	N/A	Yes
PHPW1	12	N/A	Yes
TVPW	13	N/A	No
FRPW	10	12	Yes
CHPW1	6	N/A	yes
Total	120.7	19.7	
Total (separate abstraction meters only)	40.7	12.0	

This uncertainty has been applied using a triangular distribution

Table 10: Abstraction licence-constrained sources: headroom distribution for metering inaccuracy

	Annual Average	Peak Week
Minimum Loss (gain in DO)	-0.81 Ml/d	-0.24 Ml/d
Best Estimate	0 Ml/d	0 Ml/d
Maximum Loss (loss in DO)	+0.81 Ml/d	+0.24 Ml/d

3.1.6.2 Infrastructure (Pump Capacity) Constraints

The table below summarises the groundwater source deployable outputs that are constrained by pumping capacity.

Table 11: Infrastructure (pump capacity)-constrained sources D.O.

Source	Average Deployable Output affected Ml/d	Peak Week Deployable Output affected Ml/d
COPW	N/A	18.0
ASPW	N/A	18.0
MAPW1	N/A	0.52
Total	0.0	36.5

An overall uncertainty around pumping capacity has been derived from the detailed breakdown. This is +/- 5%. This uncertainty has been applied using a triangular distribution

Table 12: Infrastructure (pump capacity)-constrained sources: headroom distribution

	Annual Average	Peak Week
Minimum Loss (gain in DO)	0 Ml/d	-1.83 Ml/d
Best Estimate	0 Ml/d	0 Ml/d
Maximum Loss (loss in DO)	0 Ml/d	+1.83 Ml/d

3.1.6.3 Pumping Water Level

No sources are constrained by potential yield.

3.1.6.4 Treatment Capacity

The following sources are constrained by treatment works capacity:

Table 13: Treatment-constrained sources D.O.

	Source	Average Deployable Output affected Ml/d	Peak Week Deployable Output affected Ml/d
GW	PRPW1	N/A	20.08
GW	HIPW1	5.0	5.0
GW	LHPW1	N/A	5.0
	PHPW	N/A	12.0
	CCPW1	N/A	6.0
SW	Central WTW	N/A	110.0
SW	River Severn WTW	N/A	207.8
	Total	GW 5.0 SW 0.0	GW 48.0 SW 317.8

Operational staff have confirmed that the range of uncertainty around groundwater treatment processes is small and so the Company has assumed a +/- 2% figure in headroom. The following range of uncertainty proposed is based on a triangular distribution:

Table 14: Treatment-constrained sources: headroom distribution

Groundwater	Annual Average	Peak Week
Minimum Loss (gain in DO)	-0.10 Ml/d	-0.96 Ml/d
Best Estimate	0 Ml/d	0 Ml/d
Maximum Loss (loss in DO)	+0.10 Ml/d	+0.96 Ml/d

3.1.6.5 Water Quality (Sand Pumping)

Five sources are constrained by sand production (causing excessive turbidity). The relevant constraints are identified below:

Table 15: Water quality-constrained sources D.O.

Source	Average Deployable Output affected in Ml/d	Peak Week Deployable Output affected in Ml/d	Range in DO
CRPW1	5.5	5.5	+2%/-10%
MBPW	N/A	9.0	+2%/-10%
HOPW	2.5	2.5	+2%/-10%
SEPW	N/A	5.0	+2%/-10%
TVPW	N/A	15	+2%/-10%
Total	8.0	37.0	+2%/-10%

The proposed headroom uncertainty for water quality (sand pumping) is a triangular function as follows:

Table 16: Water quality-constrained sources: headroom distribution

	Annual Average	Peak Week
Minimum Loss (gain in DO)	-0.16 Ml/d	-0.74 Ml/d
Best Estimate	0 Ml/d	0 Ml/d
Maximum Loss (loss in DO)	+0.80 Ml/d	+3.7 Ml/d

3.1.7 Accuracy of data for surface water yields

The modelling of deployable output from surface water sources is dependent upon the accuracy of hydrological records and the uncertainty around the derived river flows from catchment models. The Company has two surface water sources, the River Severn and Blithfield Reservoir, and the yield of these sources is modelled within the water resources model Aquator.

3.1.7.1 The River Severn (River Severn WTW)

The deployable output of River Severn is constrained by the river flow at Bewdley, storage at Clywedog, and by the status of River Regulation (releases from Clywedog Reservoir and the Shropshire Groundwater Scheme). These parameters are modelled by Severn Trent Water using the regional AQUATOR model, and the output is used as a constraint in the SSW Aquator model.

UKWIR guidance (ref 02/WR/13/2, p.29) suggests that the accuracy of river flow data derived from catchment models is +/- 10 to 20%. In addition to data accuracy, the models used may not fully represent the catchments. On this basis, the total uncertainty around the catchment modelling is assumed to be at the lower end +/-10%, given the extensive work carried out this AMP, although the impact on deployable outputs may be somewhat lower than this.

The dry year annual D.O. at River Severn is dependent on catchment modelling of inflows to Clywedog reservoir, and inflows to the catchments on the Severn upstream of Bewdley. Data and modelling uncertainty could impact on the ‘reliable yield’ of River Severn during River

Regulation. We have retained the assumptions agreed with the Environment Agency for the PR09 FWRMP of +/ 5.0% for the range of error in dry year annual deployable output.

Given the complex range of constraints, a pragmatic approach has been taken with an uncertainty range of +/- 5% around the modelled average DO value of 118.5 Ml/d (excluding Wolverhampton bulk export). This equates to +/- 5.9 Ml/d.

The peak week D.O. is largely constrained by treatment capacity. For River Severn, the same 2% uncertainty applies to this as for groundwater sites.

3.1.7.2 Blithfield Reservoir

The inflow from the Upper River Blithe directly affects reservoir storage levels, and hence deployable output. The total uncertainty around the catchment modelling is again assumed to be +/-15% and this has been confirmed by sensitivity testing of the Blithfield HYSIM models during refinement of the Aquator model. The range of uncertainty around the dry year annual D.O. (58.72 Ml/d) is therefore estimated at +/- 10% or +/- 5.9 Ml/d.

The peak week D.O. is largely influenced by the treatment works capacity (see Section S6/1 above). For Central Works, the treatment processes are such that a larger uncertainty of 9% is appropriate.

The proposed headroom uncertainty is a triangular function as follows:

Table 17: Surface Water Yields: Headroom Distributions

	Annual Average	Peak Week
Minimum Loss (gain in DO)	-11.8 Ml/d	-14.06 Ml/d
Best Estimate	0 Ml/d	0 Ml/d
Maximum Loss (loss in DO)	+11.8 Ml/d	14.06 Ml/d

3.1.8 S8 Uncertainty of Climate Change on Deployable Output

The modelling approach used to determine the impact of climate change on deployable output is described under separate cover.

The wet and dry climate change scenarios modelled in the Aquator model represent the range of uncertainty around the mid-range scenario up to 2080. The range of uncertainty used in the headroom assessment is based on the difference between the corrected wet/dry scenarios and mid-range scenarios, as shown in the following table.

Table 18: Modelled uncertainty in D.O. resulting from climate change impacts on yield

Scenarios at 2085	Base D.O. (Ml/d)	Mid-Range Estimate	Range of Uncertainty by 2085 (Wet) (Ml/d)	Range of Uncertainty by 2085 (Dry) (Ml/d)
Dry Year	338	317 (-21)	14	-19
Peak Week	419.1	393.1 (-26)	17.4	-23.6

The wet and dry uncertainty has been extrapolated up to 2045 as a time-varying series in the headroom model, using the scale factors set down in Section 3.3.6 of the Environment Agency's water resources planning guidelines (2012).

Table 19: Climate Change Uncertainty in Deployable Output

Scenarios at 2045	Base D.O. (Ml/d)	Mid-Range Estimate	Range of Uncertainty by 2045 (Wet) (Ml/d)	Range of Uncertainty by 2045 (Dry) (Ml/d)
Dry Year	338	328.5 (-9.5)	6.3	-8.6
Peak Week	419.1	407.3 (-11.8)	7.8	-10.7

This uncertainty range has been incorporated into both dry year annual average and peak week headroom by assuming a triangular distribution with the upper and lower limits defined by the wet and dry scenario results. The mid-range estimate is assumed to be zero but the correction is incorporated within the baseline forecast. As the wet year case produces an increase in DO it is treated as negative headroom and the dry year case vice versa.

3.1.9 S9 Uncertain output of new resource developments

South Staffs Water have no new resources due to be commissioned in their baseline supply/demand forecast. Any new resources selected as options in the preferred plan will have an uncertainty allowance in DO assigned to the final preferred headroom values.

3.2 Demand Components

3.2.1 D1/1 Accuracy of sub-component data

Potential errors in the measurement of distribution input are an important component of headroom and are accounted for here. Only errors on meters which measure distribution input separately to abstraction are accounted for, otherwise there would be a double count because abstraction (metering) error is identified under S6/1.

The Company has assumed an equal accuracy measurement of +/- 2% over the planning period. This will not be altered by subsequent meter replacements. Those distribution input meters that are separate from the source meters are listed in the following table.

Table 20: Source Deployable Output and Distribution Input Meter Status

SOURCE NAME	PR14 Annual Average D.O. (Ml/d)	PR14 Peak Week D.O. (Ml/d)	Separate Distribution input meter
SMPW	5.0	5.0	Yes
MGPW	2.7	2.7	Yes
SEPW	5.0	5.0	Yes
MBPW	8.5	9.0	No
CRPW1	5.5	5.5	Yes
CHPW1	10.0	10.0	No
COPW	15.0	18.0	No
KIPW1	9.0	9.0	No
PRPW1	20.0	20.0	No
ASPW	18.0	18.0	No
HIPW	5.6	5.6	No
MAPW1	0.52	0.52	No
HOPW	2.45	2.45	No
SHPW	0.0	0.0	Yes
SOPW	0.0	0.0	Yes
BVPW	4.8	4.8	No

SOURCE NAME	PR14 Annual Average D.O. (Ml/d)	PR14 Peak Week D.O. (Ml/d)	Separate Distribution input meter
LHPW1	5.0	5.0	Yes
SSPW	0.0	0.0	Yes
PHPW	12.0	12.0	Yes
TVPW	13.7	15.0	Yes
FRPW	10	12	Yes
CCPW1	6.5	6.6	Yes
Total groundwater DO	157.9	165.6	
Total GW DO separate DI meters	51.3	55.6	
River Severn Works	118.5	159.0	Yes
Central Works	58.7	91.3	Yes
Total surface water DO	177.2	250.3	
Total DO	372.9	457.9	
Total DO with separate DI meters	228.5	305.9	

The total DO with separate DI meters is less than the demand forecast at DYAA and DYCP across planning period; therefore, headroom uncertainty is constant. A triangular distribution based an uncertainty of +/- 2% is applied as follows:

Table 21: Distribution Input Meter Accuracy: Headroom Distribution

	Annual Average	Peak Week
Minimum Headroom (decrease in demand)	-4.6 Ml/d	-6.1 Ml/d
Best Estimate	0 Ml/d	0 Ml/d
Maximum Headroom (increase in demand)	+4.6 Ml/d	+6.1 Ml/d

3.2.2 D2/1 Demand Forecasting Uncertainty

This element of headroom accounts for the uncertainty around the forecasts of individual demand components. Uncertainty must be estimated on the normal year forecasts as the dry year adjustment is added on to the normal year demand as an aggregate figure at the end. In order to account for any additional uncertainty resulting from the dry year adjustment this is included as well.

Components have been included for population, housing growth, measured and unmeasured demand and leakage as well as the switching forecast. Uncertainty in the peak demand forecast and in the dry year factor used in the annual average demand forecast have also been considered. The headroom approach for each component of the demand forecast is described below.

- Household Consumption: Uncertainty in population, growth in number of properties, measured and unmeasured per capita consumption, household growth, number of meter optants and dry year adjustment has been assessed and compiled into a single set of values for upper and lower bounds, input to the model as a triangular distribution centred on the baseline forecast. For the population and properties uncertainty, we apply the UKWIR guideline errors to a normal distribution. Modelling error was accounted for using normally distributed regression coefficients (an assumption consistent with using ordinary

least squares as the best linear unbiased estimator). The overall Household Consumption uncertainty is +/-13.22Ml/d by 2045 for DYAA conditions, and +18 Ml/d to -19.1 Ml/d by 2045 for DYCP conditions.[1]

- Non-Household Consumption: Uncertainty around non-household consumption is estimated to be +/-5.06 Ml/d by 2045. This range was determined by looking at the range of different forecasts that were derived from different trend analyses and or linear models (with economic variables) and taking the mean/median and standard deviation of the distribution of these forecasts.[1]
- Leakage: Uncertainty around leakage has been determined as +/-5% of target leakage. This equates to +/-3.4 Ml/d in 2018, decreasing to +/-2.9 Ml/d by 2045: a triangular distribution has been used accordingly. This is consistent with work on SELL for the business plan.
- There are also uncertainties surrounding predicted peak consumption volumes used in the supply demand balance. This is because dry years do not occur regularly and the predicted demands do not always coincide with supply shortfalls. Review of historic data was used to define a triangular distribution between +/- 10 Ml/d for uncertainty in critical period uplift factor.

For each year the uncertainties for each consumption category are added together within the headroom model to give an overall uncertainty for the demand forecasts. The percentages are calculated from demand excluding SPL and MUR. The table below demonstrates the size of the demand component for key years in the forecast.

Table 22: Total Demand Headroom Annual Average 5 yearly intervals

Annual Average	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Minimum Headroom (decrease in demand)	-7.12	-10.67	-13.85	-16.33	-18.77	-21.21
Best Estimate	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Headroom (increase in demand)	7.12	10.67	13.85	16.33	18.77	21.21

The approach to assessing the demand component for peak week headroom uncertainty is the same as that for annual average except that the dry year adjustment component is replaced with that for since peak week volume uncertainty.

Table 23: Total Demand Headroom Peak Week 5 yearly intervals

Peak Week	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
Minimum Headroom (decrease in demand)	-17.33	-24.33	-30.24	-32.37	-34.71	-37.11
Best Estimate	0.00	0.00	0.00	0.00	0.00	0.00
Maximum Headroom (increase in demand)	15.83	19.68	23.81	27.90	31.96	35.99

3.2.3 Uncertainty of impact of Climate Change on Demand

The impact of climate change on demand was previously assessed using the techniques developed in the UKWIR study, Impact of Climate Change on Demand. This has used statistical analyses performed on PCC data from Thames Water and Severn Trent Water to

[1] Artesia Consulting (2018) SST & CAM uncertainty D2-D3 outputs 2018-08-07.xls

generate regression models relating demand to climatic data. These models have been used in combination with UKCP09 climate projections to derive algorithms and look-up tables for each UK region.

The Company has selected the Severn Trent water model as it better simulates the water using behaviour of the South Staffs customer base. It has used probability data on increase in demand in the South Humber region as this geographically matches the majority of its supply area. The data tables contain forecast values for the percentage increase in household consumption and these have been directly applied using Company average PCC values on an annual basis.

The table below shows the range of uncertainty associated with the forecast annual average impact of climate change on demand. All impacts are scaled to a mid-value of zero to avoid double counting the base CC demand impacts (which are included in baseline demand). Probability data have been used to produce a triangular distribution.

Table 24: Climate Change Demand Uncertainty Annual Average: 5 yearly Headroom

Annual Average	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
P10 Headroom Ml/d	0.07	0.31	0.55	0.79	1.03	1.31
P50 Headroom Ml/d	0.00	0.00	0.00	0.00	0.00	0.00
P90 Headroom Ml/d	-0.07	-0.24	-0.44	-0.62	-0.82	-1.01

Table 25: Climate Change Demand Uncertainty Peak Week: 5 yearly Headroom

Peak Week	2019/20	2024/25	2029/30	2034/35	2039/40	2044/45
P10 Headroom Ml/d	0.34	1.23	2.14	3.10	4.09	5.08
P50 Headroom Ml/d	0.00	0.00	0.00	0.00	0.00	0.00
P90 Headroom Ml/d	-0.24	-0.85	-1.52	-2.21	-2.89	-3.59

3.3 Analysing the data

Once the distributions are selected, they are built into the @Risk model. The model is then run for 10,000 iterations to produce the combined headroom. The in-built sensitivity functions are used to analyse which inputs have the greatest impact on the result.

4 Results and conclusions

4.1 Target Headroom Results

4.1.1 DYAA

The results of the target headroom modelling under dry year average conditions are shown in Figure 1 below. A full table of results by percentile is presented in Appendix A. The chosen risk profile is also shown. Target headroom starts at 7.0 Ml/d in 2018, increasing steadily along the 95th percentile profile to a maximum of 9.9 Ml/d in 2030. The increase in risk acceptance beyond 2030 means that target headroom decreases slowly thereafter to 7.8 Ml/d by 2045.

Figure 1: DYAA Target Headroom Results and chosen risk profile

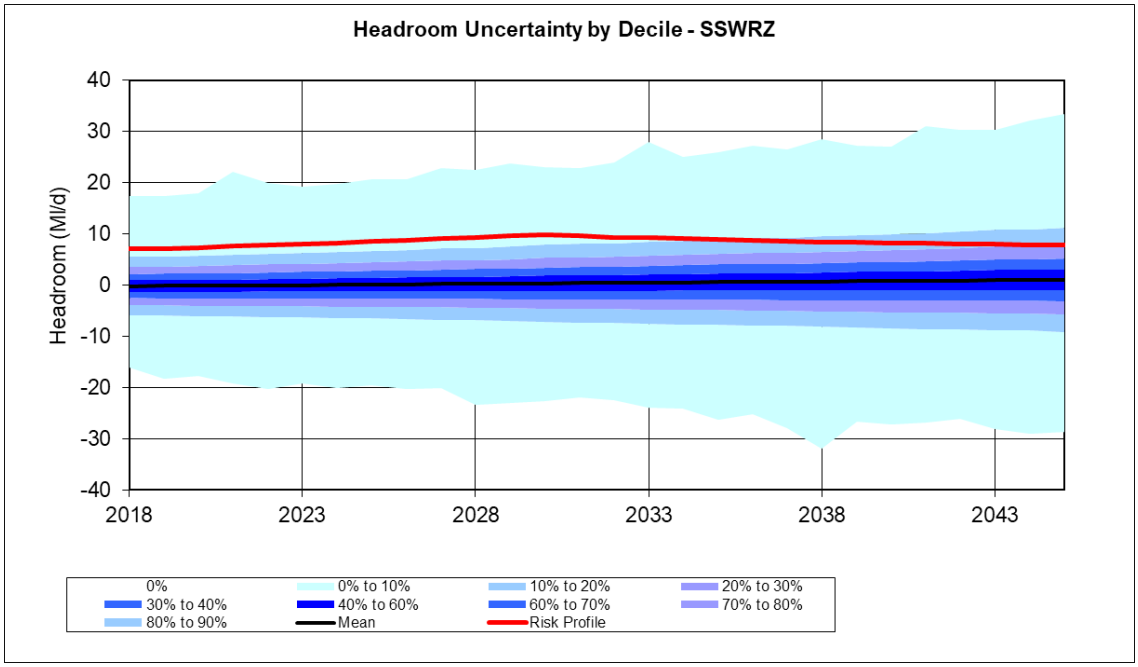
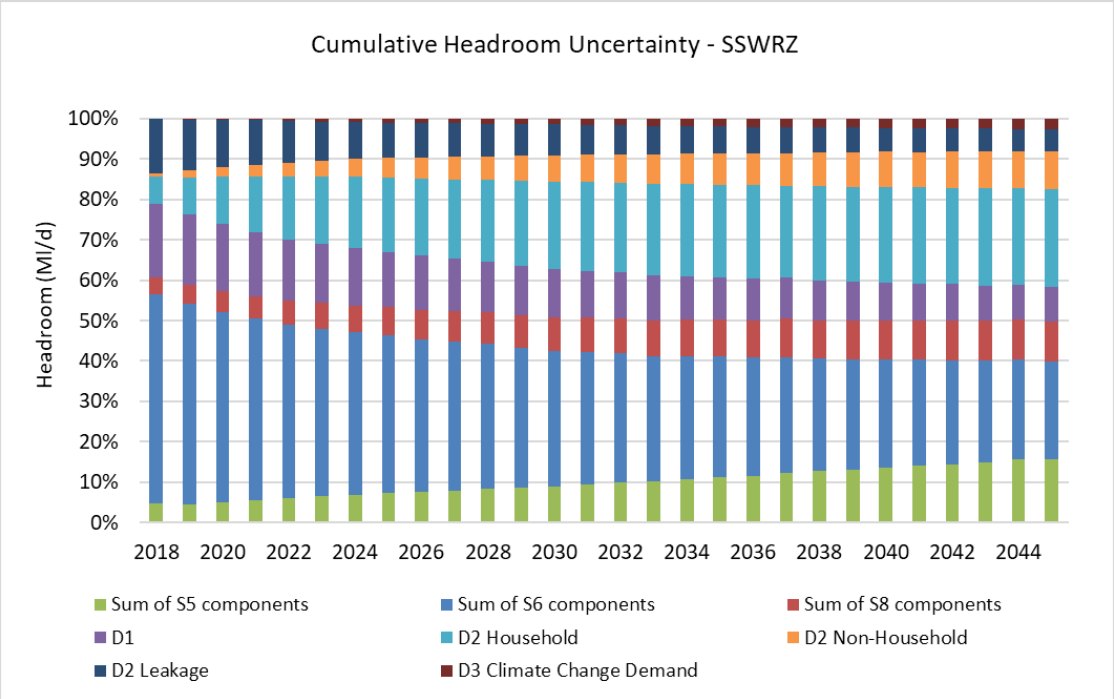


Figure 2 shows the proportional breakdown of target headroom by component for the selected risk profile. In the early years, uncertainty is dominated by S6 supply-side uncertainty, especially relating to potential yield of surface water sources. There is some demand uncertainty as a result of potential distribution input meter inaccuracy. As time progresses, uncertainty relating to demand increases steadily as a proportion of overall headroom, with accompanying proportional increases in supply-side climate change and groundwater contamination uncertainty.

Figure 2: % Breakdown of DYAA Target Headroom by sub-component



4.1.2 DYCP

The results of the target headroom modelling under dry year critical period conditions are shown in Figure 3 below. A full table of results by percentile is presented in Appendix A. The chosen risk profile is also shown. Target headroom starts at 11.6 Ml/d in 2018, increasing steadily along the 95th percentile profile to a maximum of 13.7 Ml/d in 2030. The increase in risk acceptance beyond 2030 means that target headroom fluctuates slightly thereafter, finishing at 12.8 Ml/d by 2045.

Figure 3: DYCP Target Headroom Results and chosen risk profile

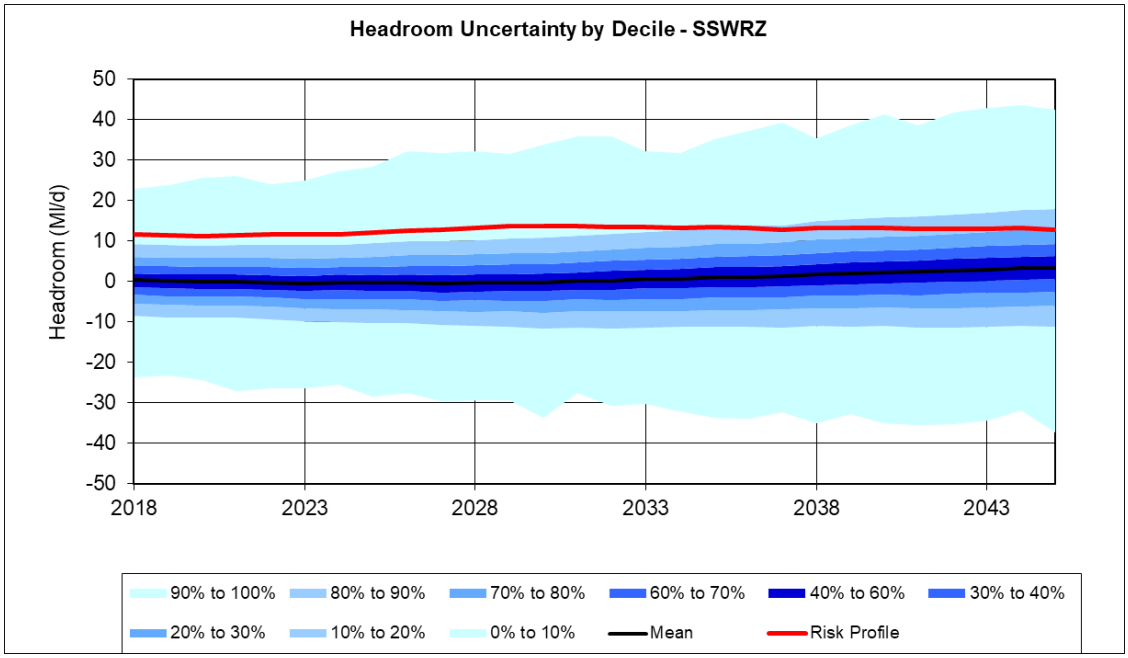
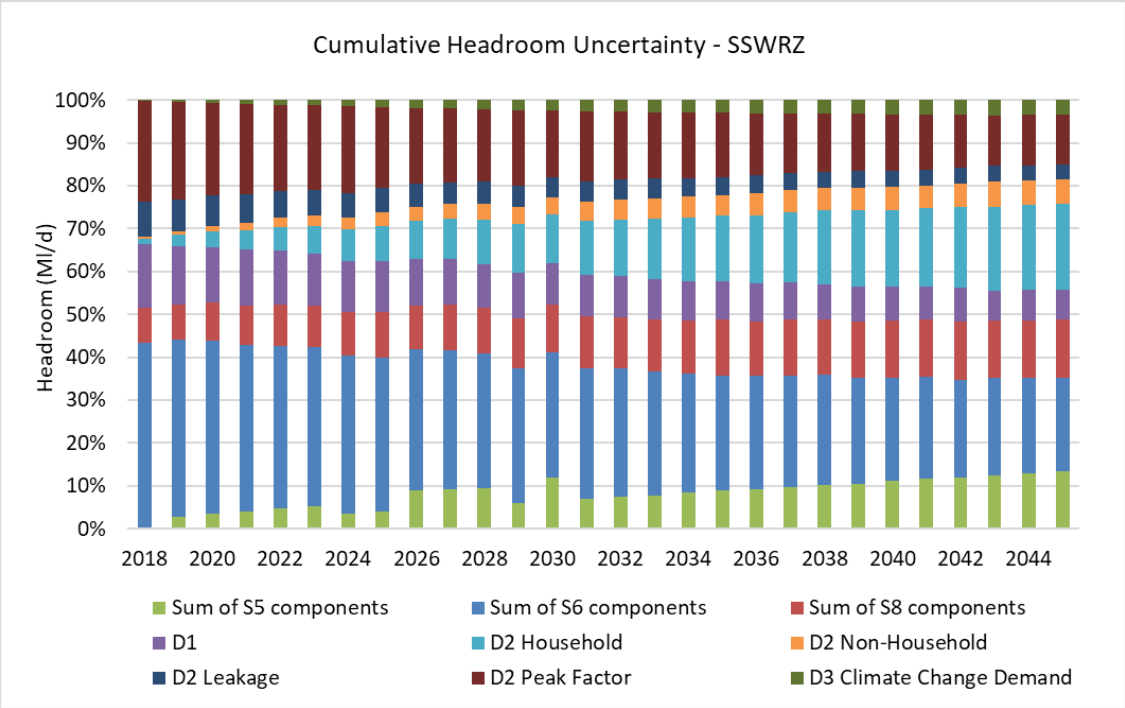


Figure 4 shows the proportional breakdown of target headroom by component for the selected risk profile. In the early years, uncertainty is dominated by S6 supply-side uncertainty, especially relating to potential yield of surface water sources. There is some demand uncertainty as a result of potential distribution input meter inaccuracy. As time progresses, uncertainty relating to demand increases steadily as a proportion of overall headroom, with accompanying proportional increases in supply-side climate change and groundwater contamination uncertainty.

Figure 4: % Breakdown of DYCP Target Headroom by sub-component



4.2 Chosen Risk Profile

The headroom values for the chosen risk profile for each year of the planning period and the corresponding percentiles, both for DYAA and DYCP / Peak are summarised in the tables below. South Staffordshire Water is accepting a higher level of risk in the future than at present which is expected as, over time, aspects of uncertainty included in headroom will be resolved.

Table 26: Headroom values in Ml/d and corresponding %iles for the chosen risk profile (DYAA)

Year	DYAA Headroom (all components)	DYAA (%ile)	DYAA Headroom (climate change components)
2017 / 18	7.05	95%	0.30
2018 / 19	7.19	95%	0.36
2019 / 20	7.29	95%	0.40
2020 / 21	7.56	95%	0.45
2021 / 22	7.82	95%	0.52
2022 / 23	7.96	95%	0.57
2023 / 24	8.26	95%	0.62
2024 / 25	8.57	95%	0.69
2025 / 26	8.75	95%	0.75
2026 / 27	9.01	95%	0.80
2027 / 28	9.22	95%	0.86
2028 / 29	9.61	95%	0.92
2029 / 30	9.91	95%	0.99
2030 / 31	9.58	94%	0.98
2031 / 32	9.30	93%	0.98
2032 / 33	9.21	92%	1.00
2033 / 34	9.06	91%	1.00
2034 / 35	8.90	90%	1.00
2035 / 36	8.75	89%	1.01
2036 / 37	8.53	88%	1.00
2037 / 38	8.45	87%	0.99
2038 / 39	8.40	86%	1.02
2039 / 40	8.19	85%	1.00
2040 / 41	8.10	84%	1.01
2041 / 42	8.07	83%	1.02
2042 / 43	8.03	82%	1.02
2043 / 44	7.78	81%	0.99
2044 / 45	7.77	80%	1.00

Table 27: Headroom values in Ml/d and corresponding %iles for the chosen risk profile (DYCP / Peak)

Year	DYCP / Peak Headroom (all components)	DYCP / Peak (%ile)	DYCP Headroom (climate change components)
2017 / 18	11.57	95%	0.94
2018 / 19	11.28	95%	0.93
2019 / 20	11.26	95%	1.02
2020 / 21	11.47	95%	1.10
2021 / 22	11.54	95%	1.19
2022 / 23	11.64	95%	1.20
2023 / 24	11.63	95%	1.28
2024 / 25	12.04	95%	1.41
2025 / 26	12.50	95%	1.42
2026 / 27	12.67	95%	1.53
2027 / 28	13.23	95%	1.60
2028 / 29	13.62	95%	1.79
2029 / 30	13.73	95%	1.74
2030 / 31	13.74	94%	1.92
2031 / 32	13.50	93%	1.91
2032 / 33	13.37	92%	1.92
2033 / 34	13.13	91%	1.93
2034 / 35	13.48	90%	2.07
2035 / 36	13.13	89%	1.99
2036 / 37	12.75	88%	2.00
2037 / 38	13.22	87%	2.05
2038 / 39	13.17	86%	2.06
2039 / 40	13.19	85%	2.12
2040 / 41	12.94	84%	2.11
2041 / 42	13.06	83%	2.17
2042 / 43	12.91	82%	2.14
2043 / 44	13.21	81%	2.15
2044 / 45	12.83	80%	2.12

4.3 Risk Profile Sensitivity

The range in target headroom between 15th and 85th percentiles is shown below. Full tables of results for DYAA and DYCP are presented in Appendix A.

Table 28: Difference between 15%ile and 85%iles in 2017/18 and 2044/45

Scenario	15-%ile (2017 / 18)	85-%ile (2017 / 18)	15-%ile (2044 / 45)	85-%ile (2044 / 45)
DYAA	-4.75	4.40	-7.22	9.31
DYCP (Peak)	-6.87	7.46	-8.47	15.15

Appendices

A. Target Headroom Uncertainty Results Tables

Table 29: DYAA Target Headroom Percentiles by Year

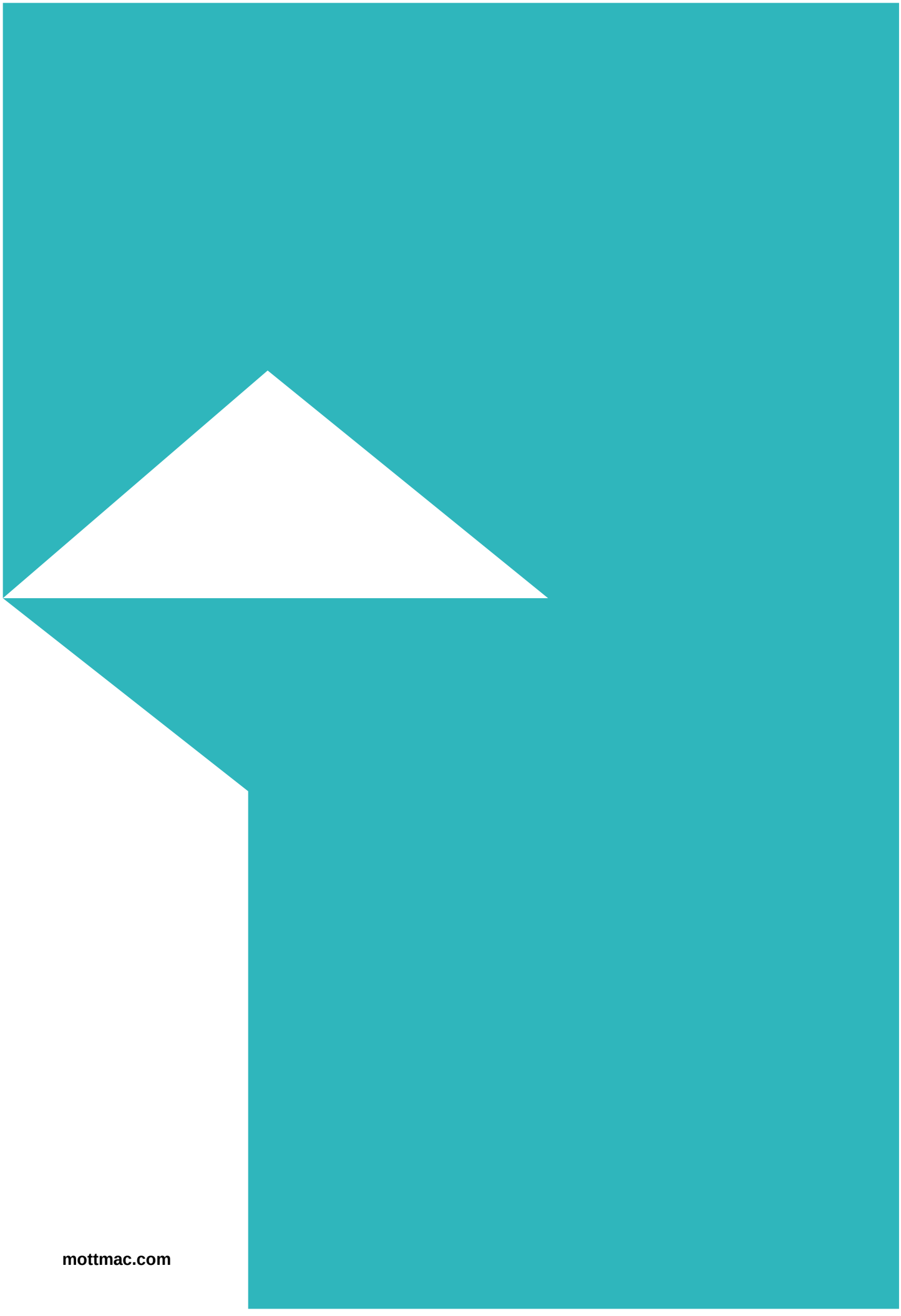
Percentiles	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
0%	-16.021	-16.130	-18.309	-17.718	-19.268	-20.368	-19.104	-20.045	-19.513	-20.225	-20.179	-23.382	-22.966	-22.599	-21.988
1%	-10.618	-10.129	-10.358	-10.625	-10.865	-11.005	-11.206	-11.436	-11.634	-11.917	-12.078	-12.463	-12.684	-13.044	-13.326
2%	-9.592	-9.020	-9.241	-9.482	-9.643	-9.799	-9.888	-10.143	-10.299	-10.540	-10.749	-11.076	-11.259	-11.520	-11.766
3%	-8.982	-8.334	-8.483	-8.742	-8.854	-9.018	-9.095	-9.319	-9.482	-9.711	-9.887	-10.145	-10.330	-10.522	-10.719
4%	-8.499	-7.791	-7.949	-8.178	-8.234	-8.438	-8.491	-8.685	-8.836	-9.067	-9.208	-9.456	-9.598	-9.779	-9.983
5%	-8.099	-7.356	-7.486	-7.725	-7.779	-7.952	-7.984	-8.176	-8.291	-8.524	-8.613	-8.886	-8.993	-9.197	-9.376
6%	-7.726	-6.996	-7.093	-7.296	-7.361	-7.519	-7.587	-7.749	-7.851	-8.038	-8.161	-8.421	-8.489	-8.687	-8.858
7%	-7.412	-6.660	-6.749	-6.945	-7.003	-7.139	-7.209	-7.351	-7.423	-7.629	-7.740	-7.989	-8.044	-8.228	-8.402
8%	-7.120	-6.339	-6.453	-6.586	-6.684	-6.797	-6.877	-6.993	-7.071	-7.252	-7.371	-7.597	-7.639	-7.813	-8.006
9%	-6.857	-6.079	-6.171	-6.299	-6.384	-6.505	-6.571	-6.677	-6.733	-6.918	-7.038	-7.237	-7.291	-7.455	-7.643
10%	-6.616	-5.829	-5.923	-6.017	-6.110	-6.217	-6.283	-6.379	-6.452	-6.609	-6.741	-6.905	-6.950	-7.123	-7.285
11%	-6.399	-5.595	-5.685	-5.780	-5.850	-5.954	-6.025	-6.114	-6.176	-6.318	-6.450	-6.607	-6.655	-6.820	-6.980
12%	-6.199	-5.365	-5.452	-5.544	-5.606	-5.708	-5.785	-5.859	-5.909	-6.059	-6.177	-6.321	-6.371	-6.530	-6.660
13%	-6.004	-5.153	-5.243	-5.315	-5.380	-5.485	-5.549	-5.627	-5.658	-5.807	-5.907	-6.037	-6.093	-6.257	-6.364
14%	-5.822	-4.955	-5.036	-5.105	-5.167	-5.271	-5.323	-5.394	-5.426	-5.566	-5.660	-5.783	-5.843	-5.989	-6.097
15%	-5.643	-4.753	-4.844	-4.909	-4.973	-5.048	-5.105	-5.188	-5.215	-5.323	-5.423	-5.537	-5.605	-5.732	-5.834
16%	-5.477	-4.573	-4.654	-4.723	-4.785	-4.852	-4.900	-4.986	-5.017	-5.100	-5.195	-5.294	-5.383	-5.499	-5.597
17%	-5.310	-4.386	-4.476	-4.539	-4.600	-4.654	-4.699	-4.782	-4.801	-4.895	-4.974	-5.073	-5.158	-5.264	-5.355
18%	-5.156	-4.229	-4.306	-4.371	-4.420	-4.462	-4.523	-4.582	-4.600	-4.691	-4.764	-4.859	-4.947	-5.055	-5.129
19%	-5.005	-4.078	-4.137	-4.200	-4.252	-4.282	-4.339	-4.393	-4.406	-4.500	-4.558	-4.661	-4.729	-4.842	-4.902
20%	-4.857	-3.912	-3.973	-4.037	-4.083	-4.107	-4.163	-4.209	-4.217	-4.298	-4.361	-4.459	-4.532	-4.642	-4.685
21%	-4.705	-3.760	-3.823	-3.875	-3.916	-3.936	-3.985	-4.038	-4.035	-4.103	-4.172	-4.263	-4.327	-4.428	-4.485
22%	-4.563	-3.605	-3.664	-3.716	-3.759	-3.776	-3.814	-3.874	-3.861	-3.927	-3.989	-4.081	-4.132	-4.226	-4.275
23%	-4.424	-3.457	-3.519	-3.569	-3.602	-3.619	-3.641	-3.701	-3.693	-3.753	-3.814	-3.886	-3.938	-4.037	-4.064
24%	-4.292	-3.316	-3.370	-3.419	-3.452	-3.460	-3.477	-3.535	-3.528	-3.580	-3.646	-3.702	-3.751	-3.855	-3.868
25%	-4.161	-3.178	-3.222	-3.279	-3.313	-3.311	-3.323	-3.385	-3.370	-3.416	-3.478	-3.531	-3.561	-3.663	-3.675
26%	-4.031	-3.049	-3.091	-3.136	-3.165	-3.158	-3.166	-3.222	-3.216	-3.251	-3.304	-3.359	-3.382	-3.479	-3.500
27%	-3.910	-2.916	-2.956	-2.994	-3.018	-3.012	-3.019	-3.066	-3.057	-3.080	-3.139	-3.194	-3.215	-3.305	-3.312
28%	-3.783	-2.789	-2.816	-2.853	-2.871	-2.873	-2.874	-2.914	-2.902	-2.923	-2.972	-3.022	-3.056	-3.126	-3.127
29%	-3.660	-2.653	-2.686	-2.720	-2.730	-2.736	-2.730	-2.764	-2.756	-2.769	-2.812	-2.870	-2.895	-2.951	-2.948
30%	-3.539	-2.528	-2.558	-2.587	-2.593	-2.587	-2.582	-2.619	-2.604	-2.620	-2.648	-2.703	-2.732	-2.777	-2.777
31%	-3.419	-2.402	-2.429	-2.457	-2.458	-2.453	-2.437	-2.477	-2.463	-2.470	-2.497	-2.545	-2.570	-2.601	-2.608
32%	-3.302	-2.282	-2.299	-2.322	-2.323	-2.314	-2.303	-2.333	-2.314	-2.325	-2.342	-2.393	-2.403	-2.431	-2.437
33%	-3.188	-2.156	-2.178	-2.197	-2.185	-2.179	-2.163	-2.198	-2.172	-2.176	-2.188	-2.236	-2.235	-2.276	-2.271
34%	-3.071	-2.035	-2.052	-2.069	-2.059	-2.044	-2.036	-2.058	-2.035	-2.038	-2.038	-2.084	-2.081	-2.112	-2.105
35%	-2.958	-1.918	-1.930	-1.944	-1.936	-1.908	-1.899	-1.918	-1.900	-1.893	-1.890	-1.930	-1.923	-1.950	-1.934
36%	-2.850	-1.790	-1.806	-1.822	-1.809	-1.779	-1.771	-1.775	-1.763	-1.753	-1.745	-1.785	-1.765	-1.789	-1.774
37%	-2.734	-1.672	-1.680	-1.699	-1.685	-1.645	-1.643	-1.642	-1.627	-1.617	-1.605	-1.639	-1.610	-1.630	-1.616
38%	-2.622	-1.549	-1.562	-1.579	-1.555	-1.515	-1.508	-1.509	-1.483	-1.468	-1.467	-1.489	-1.462	-1.475	-1.453
39%	-2.514	-1.435	-1.439	-1.462	-1.433	-1.388	-1.373	-1.379	-1.346	-1.331	-1.332	-1.348	-1.316	-1.321	-1.286
40%	-2.406	-1.318	-1.325	-1.337	-1.306	-1.262	-1.255	-1.252	-1.214	-1.194	-1.194	-1.203	-1.163	-1.168	-1.127
41%	-2.297	-1.206	-1.212	-1.219	-1.180	-1.139	-1.120	-1.115	-1.084	-1.055	-1.050	-1.057	-1.016	-1.020	-0.978
42%	-2.189	-1.088	-1.094	-1.093	-1.064	-1.013	-0.989	-0.988	-0.951	-0.913	-0.909	-0.915	-0.869	-0.872	-0.827
43%	-2.076	-0.970	-0.980	-0.980	-0.945	-0.889	-0.863	-0.861	-0.815	-0.781	-0.771	-0.772	-0.718	-0.717	-0.669
44%	-1.972	-0.853	-0.862	-0.860	-0.827	-0.772	-0.739	-0.737	-0.686	-0.643	-0.624	-0.627	-0.576	-0.568	-0.526
45%	-1.863	-0.741	-0.745	-0.741	-0.708	-0.649	-0.617	-0.606	-0.557	-0.507	-0.488	-0.486	-0.433	-0.419	-0.370
46%	-1.756	-0.629	-0.623	-0.626	-0.585	-0.522	-0.487	-0.478	-0.423	-0.374	-0.355	-0.346	-0.289	-0.274	-0.213
47%	-1.652	-0.516	-0.508	-0.504	-0.463	-0.395	-0.364	-0.348	-0.295	-0.244	-0.222	-0.215	-0.141	-0.124	-0.062
48%	-1.546	-0.405	-0.400	-0.392	-0.348	-0.278	-0.242	-0.226	-0.162	-0.115	-0.089	-0.073	0.004	0.020	0.094
49%	-1.441	-0.293	-0.294	-0.275	-0.227	-0.156	-0.124	-0.097	-0.031	0.019	0.050	0.065	0.152	0.175	0.249
50%	-1.335	-0.181	-0.179	-0.162	-0.112	-0.031	0.004	0.034	0.102	0.150	0.189	0.204	0.294	0.324	0.398
51%	-1.230	-0.074	-0.071	-0.046	0.009	0.087	0.127	0.171	0.234	0.279	0.333	0.344	0.439	0.474	0.547
52%	-1.128	0.036	0.035	0.067	0.126	0.210	0.246	0.297	0.368	0.409	0.470	0.477	0.581	0.620	0.700
53%	-1.026	0.150	0.151	0.189	0.247	0.333	0.364	0.426	0.501	0.540	0.611	0.617	0.724	0.770	0.844
54%	-0.920	0.257	0.266	0.300	0.366	0.454	0.489	0.547	0.631	0.672	0.756	0.756	0.869	0.922	1.000
55%	-0.811	0.374	0.382	0.417	0.490	0.578	0.613	0.672	0.765	0.806	0.897	0.894	1.014	1.074	1.153
56%	-0.708	0.488	0.504	0.537	0.608	0.701	0.734	0.804	0.888	0.940	1.024	1.036	1.155	1.226	1.308
57%	-0.598	0.602	0.624	0.652	0.723	0.823	0.858	0.930	1.017	1.077	1.162	1.182	1.297	1.371	1.459
58%	-0.492	0.715	0.738	0.769	0.843	0.942	0.987	1.058	1.139	1.214	1.303	1.325	1.441	1.523	1.610
59%	-0.388	0.834	0.851	0.886	0.958	1.069	1.115	1.192	1.273	1.355	1.451	1.467	1.589	1.677	1.766
60%	-0.281	0.952	0.967	1.000	1.079	1.190	1.242	1.322	1.416	1.492	1.594	1.606	1.741	1.833	1.917
61%	-0.172	1.064	1.087	1.120	1.204	1.312	1.366	1.455	1.550	1.631	1.735	1.748	1.884	1.983	2.069
62%	-0.057	1.182	1.205	1.242	1.328	1.436	1.489	1.580	1.680	1.769	1.868	1.893	2.032	2.138	2.228
63%	0.049	1.294	1.319	1.359	1.459	1.563	1.619	1.710	1.816	1.913	2.015	2.034	2.189	2.293	2.388
64%	0.156	1.414	1.436	1.475	1.579	1.689	1.748	1.840	1.943	2.052	2.156	2.180	2.350	2.460	2.544
65%	0.264	1.539	1.557	1.602	1.704	1.821	1.883	1.980	2.088	2.196	2.298	2.338	2.491	2.624	2.707
66%	0.373	1.657	1.686	1.729	1.834	1.948	2.015	2.115	2.232	2.335	2.438	2.483	2.644	2.789	2.869
67%	0.482	1.782	1.806	1.851	1.963	2.082	2.155	2.255	2.377	2.478	2.585	2.633	2.796	2.946	3.027
68%	0.595	1.909	1.933	1.976	2.099	2.221	2.292	2.389	2.520	2.624	2.736	2.787	2.956	3.108	3.199
69%	0.708	2.034	2.058	2.099	2.230	2.366	2.430	2.532	2.664	2.763	2.890	2.936	3.110	3.277	3.376
70%	0.823	2.164	2.192	2.234	2.365	2.513	2.570	2.681	2.819	2.912	3.044	3.099	3.278	3.443	3.551
71%	0.938	2.279	2.327	2.368	2.507	2.647	2.721	2.830	2.967	3.068	3.196	3.257	3.452	3.605	3.714
72%	1.063	2.413	2.464	2.502	2.651	2.790	2.865	2.969	3.116	3.221	3.355	3.422	3.627	3.777	3.884
73%	1.185	2.542	2.605	2.631	2.793	2.944	3.005	3.131	3.277	3.380	3.507	3.589	3.802	3.959	4.060
74%	1.311	2.674	2.745	2.773	2.942	3.097	3.158	3.280	3.431	3.547	3.673	3.755	3.978	4.143	4.239
75%	1.444	2.816	2.880	2.921	3.082	3.248	3.304	3.439	3.596	3.710	3.841	3.924	4.153	4.323	4.424
76%	1.569	2.959	3.028	3.073	3.231	3.400	3.458	3.601	3.760	3.873	4.020	4.109	4.335	4.504	4.617
77%	1.704	3.099	3.172	3.227	3.383	3.560	3.621	3.754	3.927	4.042	4.211	4.285	4.515	4.702	4.814
78%	1.844	3.239	3.314	3.380	3.543	3.718	3.775	3.927	4.101	4.216	4.392	4.470	4.704	4.888	5.014
79%	1.988	3.382	3.465	3.538	3.709	3.879	3.940	4.095	4.280	4.392	4.571	4.657	4.897	5.091	5.213
80%	2.133	3.539	3.614	3.695	3.871	4.054	4.114	4.269	4.458	4.591	4.761	4.847	5.099	5.306	5.423
81%	2.274	3.705	3.773	3.870	4.047	4.224	4.281	4.441	4.644	4.776	4.951	5.042	5.300	5.528	5.638
82%	2.436	3.866	3.949	4.031	4.226	4.400	4.464	4.629	4.839	4.977	5.141	5.239	5.503	5.740	5.861
83%	2.593	4.034	4.117	4.201	4.404	4.590	4.659	4.825	5.045	5.179	5.341	5.449	5.722	5.958	6.101
84%	2.760	4.214	4.301	4.375	4.586	4.783	4.863	5.033	5.259	5.404	5.568	5.658	5.937	6.194	6.343
85%	2.927	4.400	4.485	4.568	4.796	4.991	5.064	5.247	5.481	5.627	5.791	5.890	6.175	6.429	6.598
86%	3.099	4.589	4.682	4.764	4.997	5.191	5.284	5.450	5.702	5.862	6.028	6.138	6.430	6.699	6.858
87%	3.281	4.794	4.891	4.975	5.202	5.405	5.518	5.679	5.944	6.091	6.278	6.382	6.698	6.951	7.124
88%	3.490	5.013	5.110	5.186	5.423	5.619	5.751	5.934	6.193	6.354	6.537	6.646	6.983	7.231	7.397
89%	3.692	5.245	5.329	5.427	5.649	5.872	6.000	6.190	6.451	6.624	6.812	6.937	7.276	7.532	7.708
90%	3.917	5.474	5.574	5.675	5.900	6.123	6.258	6.457	6.716	6.909	7.108	7.238	7.604	7.843	8.029
91%	4.159	5.729	5.836	5.946	6.168	6.406	6.531	6.760	7.029	7.220	7.417	7.565	7.925	8.175	8.386
92%	4.406	6.021	6.121	6.232	6.465	6.712	6.845	7.083	7.357	7.536	7.753	7.895	8.294	8.536	8.762
93%	4.669	6.313	6.433	6.568	6.808	7.032	7.175	7.413	7.702	7.882	8.127	8.289	8.692	8.926	9.161
94%	4.978	6.653	6.791	6.905	7.160	7.392	7.546	7.806	8.112	8.294	8.537	8.739	9.105	9.383	**9.581**
95%	**5.329**	**7.045**	**7.191**	**7.292**	**7.561**	**7.816**	**7.963**	**8.257**	**8.567**	**8.746**	**9.014**	**9.218**	**9.608**	**9.908**	10.072
96%	5.748	7.490	7.644	7.740	8.024	8.326	8.465	8.786	9.101	9.264	9.531	9.786	10.197	10.488	10.677
97%	6.260	8.011	8.193	8.308	8.616	8.910	9.081	9.447	9.761	9.924	10.230	10.480	10.937	11.189	11.426
98%	6.894	8.759	8.913	9.084	9.370	9.710	9.905	10.258	10.586	10.787	11.099	11.372	11.908	12.129	12.396
99%	7.890	9.895	10.057	10.250	10.545	11.009	11.163	11.534	11.925	12.104	12.520	12.780	13.371	13.690	13.871
100%	15.391	17.442	17.415	17.903	22.072	19.935	19.266	19.774	20.682	20.702	22.863	22.499	23.707	22.972	22.763

Percentiles	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
0%	-22.481	-23.901	-24.163	-26.306	-25.264	-27.960	-32.002	-26.724	-27.250	-26.795	-26.097	-28.087	-29.031	-28.683
1%	-13.538	-13.806	-14.110	-14.119	-14.363	-14.533	-15.100	-15.321	-15.578	-15.814	-16.040	-16.446	-16.507	-16.895
2%	-11.899	-12.198	-12.492	-12.490	-12.720	-12.908	-13.323	-13.508	-13.747	-14.028	-14.053	-14.412	-14.616	-14.908
3%	-10.976	-11.140	-11.489	-11.424	-11.629	-11.788	-12.172	-12.344	-12.604	-12.790	-12.852	-13.242	-13.333	-13.682
4%	-10.169	-10.385	-10.678	-10.651	-10.836	-10.973	-11.278	-11.484	-11.720	-11.922	-11.964	-12.299	-12.392	-12.706
5%	-9.523	-9.756	-10.022	-10.022	-10.183	-10.280	-10.548	-10.791	-10.976	-11.174	-11.205	-11.497	-11.604	-11.892
6%	-8.985	-9.214	-9.452	-9.472	-9.604	-9.696	-9.944	-10.193	-10.355	-10.523	-10.565	-10.838	-10.958	-11.197
7%	-8.544	-8.734	-8.951	-8.967	-9.101	-9.204	-9.412	-9.664	-9.811	-9.940	-10.023	-10.244	-10.342	-10.590
8%	-8.126	-8.318	-8.502	-8.508	-8.668	-8.730	-8.966	-9.161	-9.311	-9.462	-9.526	-9.716	-9.801	-10.056
9%	-7.742	-7.923	-8.093	-8.105	-8.241	-8.296	-8.497	-8.708	-8.842	-9.013	-9.074	-9.239	-9.306	-9.577
10%	-7.388	-7.572	-7.716	-7.730	-7.854	-7.925	-8.095	-8.301	-8.400	-8.579	-8.627	-8.818	-8.872	-9.142
11%	-7.066	-7.238	-7.349	-7.378	-7.500	-7.574	-7.738	-7.906	-8.042	-8.209	-8.242	-8.416	-8.462	-8.731
12%	-6.739	-6.921	-7.024	-7.044	-7.161	-7.243	-7.392	-7.548	-7.682	-7.824	-7.855	-8.023	-8.065	-8.326
13%	-6.446	-6.614	-6.713	-6.750	-6.846	-6.912	-7.041	-7.201	-7.316	-7.473	-7.516	-7.673	-7.674	-7.942
14%	-6.158	-6.317	-6.404	-6.438	-6.550	-6.609	-6.745	-6.875	-6.974	-7.128	-7.177	-7.345	-7.322	-7.569
15%	-5.897	-6.049	-6.131	-6.162	-6.255	-6.317	-6.455	-6.575	-6.679	-6.803	-6.853	-7.012	-6.989	-7.218
16%	-5.649	-5.780	-5.867	-5.896	-5.976	-6.043	-6.172	-6.285	-6.370	-6.488	-6.545	-6.688	-6.679	-6.900
17%	-5.403	-5.518	-5.608	-5.627	-5.724	-5.777	-5.892	-5.986	-6.087	-6.188	-6.247	-6.374	-6.370	-6.557
18%	-5.171	-5.278	-5.366	-5.386	-5.451	-5.530	-5.613	-5.709	-5.802	-5.899	-5.953	-6.079	-6.080	-6.254
19%	-4.941	-5.043	-5.131	-5.127	-5.188	-5.276	-5.354	-5.447	-5.537	-5.631	-5.676	-5.795	-5.775	-5.973
20%	-4.724	-4.821	-4.891	-4.888	-4.944	-5.028	-5.100	-5.196	-5.278	-5.375	-5.407	-5.526	-5.504	-5.679
21%	-4.507	-4.597	-4.658	-4.661	-4.715	-4.783	-4.873	-4.944	-5.039	-5.119	-5.151	-5.273	-5.217	-5.410
22%	-4.303	-4.382	-4.441	-4.455	-4.485	-4.559	-4.623	-4.709	-4.803	-4.878	-4.901	-5.005	-4.950	-5.144
23%	-4.094	-4.173	-4.227	-4.248	-4.260	-4.341	-4.391	-4.456	-4.569	-4.633	-4.640	-4.746	-4.674	-4.871
24%	-3.902	-3.968	-4.010	-4.032	-4.048	-4.123	-4.173	-4.236	-4.347	-4.394	-4.396	-4.482	-4.417	-4.600
25%	-3.705	-3.760	-3.813	-3.836	-3.842	-3.902	-3.947	-4.011	-4.109	-4.164	-4.155	-4.240	-4.171	-4.349
26%	-3.517	-3.559	-3.615	-3.625	-3.642	-3.709	-3.735	-3.788	-3.888	-3.922	-3.931	-4.000	-3.937	-4.113
27%	-3.333	-3.373	-3.424	-3.433	-3.448	-3.496	-3.531	-3.574	-3.669	-3.694	-3.711	-3.753	-3.704	-3.869
28%	-3.159	-3.185	-3.220	-3.240	-3.251	-3.288	-3.324	-3.357	-3.437	-3.480	-3.493	-3.522	-3.474	-3.633
29%	-2.972	-3.010	-3.034	-3.045	-3.055	-3.104	-3.118	-3.148	-3.225	-3.264	-3.274	-3.301	-3.260	-3.406
30%	-2.796	-2.838	-2.850	-2.860	-2.850	-2.917	-2.921	-2.954	-3.020	-3.061	-3.045	-3.083	-3.037	-3.178
31%	-2.630	-2.656	-2.670	-2.671	-2.665	-2.734	-2.733	-2.753	-2.810	-2.858	-2.841	-2.861	-2.817	-2.945
32%	-2.462	-2.474	-2.481	-2.486	-2.484	-2.546	-2.537	-2.553	-2.603	-2.653	-2.620	-2.639	-2.612	-2.714
33%	-2.290	-2.300	-2.310	-2.301	-2.305	-2.353	-2.333	-2.360	-2.405	-2.458	-2.402	-2.418	-2.397	-2.477
34%	-2.125	-2.133	-2.130	-2.122	-2.118	-2.163	-2.144	-2.170	-2.211	-2.263	-2.206	-2.214	-2.177	-2.256
35%	-1.965	-1.962	-1.954	-1.942	-1.934	-1.985	-1.950	-1.974	-2.020	-2.060	-2.015	-2.005	-1.962	-2.030
36%	-1.812	-1.793	-1.773	-1.771	-1.752	-1.808	-1.763	-1.785	-1.815	-1.864	-1.818	-1.803	-1.767	-1.807
37%	-1.644	-1.623	-1.608	-1.583	-1.574	-1.622	-1.578	-1.588	-1.629	-1.671	-1.625	-1.597	-1.564	-1.595
38%	-1.483	-1.459	-1.427	-1.406	-1.400	-1.439	-1.394	-1.392	-1.427	-1.474	-1.429	-1.384	-1.361	-1.386
39%	-1.329	-1.296	-1.251	-1.235	-1.216	-1.261	-1.214	-1.216	-1.245	-1.282	-1.239	-1.186	-1.158	-1.168
40%	-1.159	-1.135	-1.080	-1.069	-1.039	-1.081	-1.031	-1.034	-1.045	-1.084	-1.046	-0.979	-0.959	-0.962
41%	-1.000	-0.968	-0.910	-0.907	-0.875	-0.914	-0.867	-0.850	-0.866	-0.894	-0.854	-0.785	-0.758	-0.762
42%	-0.843	-0.801	-0.745	-0.746	-0.700	-0.744	-0.689	-0.672	-0.684	-0.703	-0.664	-0.585	-0.548	-0.551
43%	-0.693	-0.633	-0.580	-0.585	-0.538	-0.576	-0.513	-0.500	-0.491	-0.506	-0.462	-0.393	-0.348	-0.337
44%	-0.534	-0.473	-0.422	-0.411	-0.363	-0.405	-0.337	-0.310	-0.306	-0.327	-0.262	-0.187	-0.153	-0.130
45%	-0.374	-0.311	-0.254	-0.239	-0.196	-0.222	-0.163	-0.126	-0.121	-0.144	-0.070	0.004	0.041	0.068
46%	-0.219	-0.159	-0.097	-0.080	-0.035	-0.045	0.014	0.056	0.056	0.045	0.117	0.198	0.236	0.278
47%	-0.066	0.003	0.048	0.095	0.137	0.115	0.187	0.235	0.222	0.224	0.304	0.382	0.442	0.486
48%	0.085	0.166	0.210	0.262	0.303	0.289	0.366	0.408	0.409	0.413	0.499	0.567	0.622	0.686
49%	0.232	0.325	0.380	0.420	0.466	0.465	0.532	0.589	0.589	0.602	0.682	0.765	0.827	0.885
50%	0.388	0.483	0.534	0.573	0.620	0.625	0.709	0.764	0.773	0.785	0.880	0.955	1.015	1.083
51%	0.541	0.633	0.687	0.745	0.787	0.790	0.885	0.938	0.957	0.959	1.081	1.160	1.220	1.279
52%	0.686	0.796	0.847	0.907	0.950	0.955	1.060	1.119	1.136	1.148	1.273	1.355	1.410	1.477
53%	0.842	0.955	1.007	1.070	1.112	1.127	1.231	1.299	1.318	1.325	1.467	1.536	1.605	1.678
54%	0.996	1.114	1.166	1.246	1.284	1.289	1.402	1.474	1.505	1.511	1.657	1.725	1.798	1.873
55%	1.161	1.265	1.328	1.412	1.460	1.462	1.576	1.654	1.682	1.701	1.851	1.926	1.995	2.069
56%	1.312	1.425	1.498	1.580	1.636	1.639	1.761	1.827	1.867	1.891	2.055	2.123	2.194	2.262
57%	1.461	1.578	1.660	1.739	1.814	1.800	1.930	2.013	2.051	2.077	2.251	2.324	2.392	2.472
58%	1.624	1.742	1.822	1.912	1.986	1.965	2.105	2.204	2.240	2.269	2.437	2.523	2.595	2.669
59%	1.784	1.906	1.981	2.086	2.158	2.135	2.287	2.389	2.421	2.459	2.625	2.715	2.791	2.871
60%	1.937	2.060	2.150	2.253	2.328	2.317	2.455	2.574	2.623	2.647	2.820	2.928	2.995	3.080
61%	2.092	2.223	2.313	2.421	2.509	2.495	2.633	2.765	2.799	2.840	3.016	3.141	3.202	3.295
62%	2.252	2.383	2.478	2.595	2.680	2.682	2.816	2.952	2.975	3.029	3.216	3.345	3.402	3.498
63%	2.410	2.538	2.644	2.763	2.857	2.865	3.003	3.139	3.164	3.232	3.426	3.540	3.604	3.708
64%	2.569	2.712	2.818	2.937	3.036	3.042	3.189	3.327	3.353	3.418	3.634	3.741	3.814	3.922
65%	2.730	2.887	2.982	3.109	3.218	3.219	3.378	3.507	3.563	3.610	3.833	3.953	4.014	4.143
66%	2.900	3.048	3.152	3.287	3.400	3.403	3.557	3.700	3.755	3.810	4.037	4.166	4.219	4.348
67%	3.071	3.216	3.338	3.465	3.574	3.591	3.746	3.893	3.951	4.005	4.238	4.368	4.440	4.574
68%	3.244	3.394	3.521	3.651	3.764	3.774	3.947	4.092	4.151	4.204	4.445	4.596	4.661	4.807
69%	3.404	3.571	3.706	3.829	3.937	3.961	4.134	4.284	4.359	4.428	4.654	4.810	4.871	5.032
70%	3.580	3.752	3.888	4.011	4.130	4.152	4.326	4.484	4.554	4.642	4.867	5.025	5.089	5.249
71%	3.762	3.933	4.070	4.212	4.325	4.350	4.530	4.683	4.766	4.854	5.088	5.250	5.319	5.470
72%	3.941	4.120	4.267	4.406	4.522	4.546	4.737	4.907	4.999	5.070	5.314	5.478	5.550	5.711
73%	4.132	4.308	4.461	4.595	4.723	4.743	4.939	5.117	5.214	5.278	5.542	5.715	5.774	5.950
74%	4.310	4.501	4.664	4.794	4.919	4.952	5.140	5.335	5.440	5.506	5.773	5.959	6.000	6.187
75%	4.505	4.700	4.865	5.006	5.127	5.163	5.355	5.542	5.668	5.743	6.009	6.191	6.234	6.436
76%	4.703	4.894	5.073	5.209	5.357	5.378	5.577	5.760	5.894	5.978	6.244	6.444	6.481	6.691
77%	4.891	5.108	5.282	5.403	5.567	5.595	5.803	5.992	6.111	6.217	6.484	6.706	6.729	6.950
78%	5.100	5.307	5.496	5.626	5.794	5.816	6.036	6.228	6.340	6.463	6.733	6.956	6.972	7.217
79%	5.323	5.518	5.721	5.845	6.019	6.042	6.268	6.473	6.582	6.705	7.006	7.208	7.239	7.488
80%	5.533	5.745	5.928	6.060	6.246	6.280	6.505	6.732	6.830	6.979	7.256	7.478	7.501	**7.765**
81%	5.748	5.982	6.147	6.293	6.481	6.512	6.747	6.998	7.078	7.239	7.533	7.754	**7.776**	8.063
82%	5.988	6.218	6.390	6.530	6.730	6.755	6.994	7.258	7.354	7.521	7.801	**8.033**	8.060	8.352
83%	6.223	6.460	6.638	6.797	6.970	7.019	7.260	7.508	7.620	7.801	**8.068**	8.314	8.377	8.649
84%	6.466	6.699	6.885	7.049	7.237	7.298	7.538	7.787	7.892	**8.104**	8.366	8.612	8.679	8.950
85%	6.718	6.951	7.139	7.319	7.510	7.593	7.826	8.076	**8.187**	8.403	8.656	8.932	8.993	9.308
86%	6.971	7.212	7.424	7.602	7.795	7.874	8.124	**8.402**	8.500	8.717	8.981	9.266	9.312	9.650
87%	7.242	7.491	7.727	7.897	8.105	8.197	**8.448**	8.721	8.848	9.048	9.303	9.618	9.668	10.011
88%	7.526	7.795	8.035	8.210	8.427	**8.531**	8.782	9.039	9.182	9.414	9.653	9.970	10.028	10.395
89%	7.850	8.124	8.346	8.548	**8.753**	8.886	9.128	9.394	9.524	9.784	10.026	10.362	10.412	10.790
90%	8.164	8.466	8.685	**8.902**	9.119	9.239	9.493	9.754	9.946	10.193	10.409	10.768	10.861	11.218
91%	8.513	8.821	**9.060**	9.282	9.509	9.611	9.868	10.142	10.388	10.628	10.824	11.205	11.285	11.662
92%	8.875	**9.214**	9.454	9.675	9.911	10.034	10.315	10.580	10.818	11.081	11.306	11.654	11.767	12.144
93%	**9.303**	9.631	9.893	10.112	10.376	10.500	10.781	11.062	11.321	11.580	11.803	12.172	12.265	12.661
94%	9.761	10.098	10.361	10.600	10.879	10.995	11.298	11.574	11.862	12.104	12.378	12.751	12.858	13.282
95%	10.261	10.611	10.918	11.159	11.444	11.545	11.860	12.155	12.482	12.693	13.012	13.352	13.505	13.955
96%	10.893	11.265	11.539	11.810	12.054	12.244	12.524	12.894	13.178	13.449	13.716	14.126	14.262	14.738
97%	11.631	12.076	12.329	12.649	12.838	13.099	13.365	13.790	14.078	14.361	14.662	15.038	15.206	15.708
98%	12.671	13.081	13.385	13.688	13.876	14.163	14.459	14.896	15.242	15.574	15.832	16.248	16.445	16.998
99%	14.305	14.710	14.948	15.305	15.526	15.764	16.276	16.566	17.032	17.327	17.680	18.218	18.312	18.969
100%	23.878	27.847	24.960	25.959	27.289	26.449	28.550	27.201	27.008	30.967	30.258	30.333	32.119	33.364

Table 30: DYCP Target Headroom Percentiles by Year

Percentile	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
0%	-17.076	-23.770	-23.385	-24.414	-27.093	-26.512	-26.568	-25.656	-28.485	-27.671	-29.699	-29.332	-29.471	-33.694	-27.491
1%	-11.076	-14.318	-15.247	-15.908	-16.376	-16.747	-16.829	-17.501	-17.564	-18.067	-18.892	-19.526	-20.277	-20.581	-20.508
2%	-10.011	-12.989	-13.767	-14.200	-14.217	-14.770	-15.231	-15.684	-15.538	-16.011	-16.962	-17.078	-17.725	-18.075	-18.001
3%	-9.238	-11.949	-12.784	-12.919	-13.137	-13.752	-14.231	-14.381	-14.338	-14.839	-15.706	-15.865	-16.398	-16.768	-16.646
4%	-8.739	-11.264	-11.882	-12.229	-12.214	-12.779	-13.374	-13.512	-13.544	-14.032	-14.538	-14.764	-15.120	-15.679	-15.539
5%	-8.185	-10.558	-11.259	-11.361	-11.496	-12.085	-12.603	-12.779	-12.828	-13.255	-13.760	-13.927	-14.262	-14.885	-14.529
6%	-7.735	-10.038	-10.778	-10.708	-10.859	-11.368	-12.066	-12.184	-12.245	-12.466	-12.961	-13.345	-13.497	-14.112	-13.731
7%	-7.403	-9.658	-10.132	-10.278	-10.387	-10.798	-11.438	-11.573	-11.667	-12.010	-12.300	-12.734	-12.781	-13.524	-13.133
8%	-7.030	-9.200	-9.694	-9.860	-9.855	-10.204	-10.872	-10.964	-11.183	-11.359	-11.779	-12.166	-12.287	-12.956	-12.466
9%	-6.686	-8.736	-9.314	-9.437	-9.460	-9.797	-10.300	-10.470	-10.687	-10.920	-11.331	-11.667	-11.802	-12.377	-11.902
10%	-6.396	-8.396	-8.923	-9.046	-9.042	-9.416	-9.884	-10.070	-10.220	-10.434	-10.881	-11.119	-11.275	-11.766	-11.360
11%	-6.085	-8.037	-8.598	-8.668	-8.676	-9.043	-9.490	-9.674	-9.817	-10.044	-10.401	-10.678	-10.745	-11.220	-10.905
12%	-5.795	-7.705	-8.185	-8.327	-8.364	-8.673	-9.091	-9.248	-9.480	-9.663	-9.997	-10.323	-10.283	-10.716	-10.356
13%	-5.586	-7.426	-7.847	-7.993	-8.054	-8.342	-8.758	-8.914	-9.076	-9.313	-9.592	-9.887	-9.830	-10.323	-9.937
14%	-5.352	-7.148	-7.501	-7.680	-7.687	-8.002	-8.411	-8.625	-8.654	-8.967	-9.162	-9.470	-9.475	-9.882	-9.580
15%	-5.126	-6.869	-7.182	-7.347	-7.408	-7.708	-8.157	-8.265	-8.372	-8.648	-8.782	-9.155	-9.047	-9.483	-9.222
16%	-4.926	-6.585	-6.879	-7.005	-7.112	-7.424	-7.814	-7.967	-8.043	-8.337	-8.471	-8.835	-8.713	-9.077	-8.811
17%	-4.689	-6.297	-6.599	-6.731	-6.829	-7.167	-7.477	-7.618	-7.726	-7.999	-8.190	-8.466	-8.331	-8.711	-8.487
18%	-4.462	-6.035	-6.363	-6.457	-6.545	-6.849	-7.196	-7.334	-7.440	-7.693	-7.905	-8.151	-8.021	-8.341	-8.105
19%	-4.264	-5.766	-6.132	-6.197	-6.229	-6.549	-6.842	-7.045	-7.146	-7.386	-7.612	-7.795	-7.689	-8.045	-7.782
20%	-4.094	-5.524	-5.883	-5.908	-5.939	-6.301	-6.654	-6.824	-6.855	-7.090	-7.319	-7.517	-7.383	-7.738	-7.379
21%	-3.916	-5.294	-5.655	-5.667	-5.746	-6.003	-6.459	-6.556	-6.605	-6.819	-7.079	-7.204	-7.124	-7.352	-7.069
22%	-3.725	-5.026	-5.412	-5.426	-5.458	-5.754	-6.202	-6.297	-6.334	-6.565	-6.788	-6.929	-6.852	-7.077	-6.752
23%	-3.521	-4.786	-5.174	-5.235	-5.225	-5.475	-5.952	-6.043	-6.042	-6.244	-6.539	-6.611	-6.569	-6.791	-6.437
24%	-3.345	-4.574	-4.941	-5.020	-4.982	-5.213	-5.703	-5.796	-5.810	-6.004	-6.302	-6.301	-6.277	-6.476	-6.167
25%	-3.165	-4.351	-4.739	-4.794	-4.782	-4.953	-5.495	-5.505	-5.559	-5.726	-6.067	-6.100	-6.003	-6.181	-5.906
26%	-2.976	-4.100	-4.520	-4.583	-4.570	-4.749	-5.247	-5.257	-5.300	-5.478	-5.813	-5.832	-5.762	-5.900	-5.639
27%	-2.830	-3.878	-4.291	-4.355	-4.355	-4.566	-5.007	-5.031	-5.077	-5.252	-5.526	-5.555	-5.514	-5.653	-5.288
28%	-2.683	-3.672	-4.083	-4.126	-4.160	-4.344	-4.789	-4.767	-4.831	-5.005	-5.285	-5.280	-5.243	-5.365	-4.995
29%	-2.547	-3.499	-3.846	-3.942	-3.943	-4.166	-4.568	-4.529	-4.608	-4.779	-5.043	-5.037	-5.020	-5.137	-4.720
30%	-2.388	-3.307	-3.634	-3.740	-3.730	-3.949	-4.356	-4.313	-4.412	-4.514	-4.815	-4.748	-4.768	-4.842	-4.485
31%	-2.245	-3.149	-3.436	-3.549	-3.534	-3.736	-4.179	-4.076	-4.200	-4.266	-4.575	-4.546	-4.528	-4.581	-4.231
32%	-2.090	-2.943	-3.239	-3.355	-3.326	-3.555	-3.961	-3.880	-3.968	-4.049	-4.342	-4.320	-4.310	-4.331	-3.960
33%	-1.933	-2.725	-3.052	-3.176	-3.156	-3.382	-3.731	-3.649	-3.784	-3.839	-4.134	-4.108	-4.051	-4.035	-3.708
34%	-1.803	-2.547	-2.825	-2.971	-2.947	-3.194	-3.538	-3.423	-3.516	-3.592	-3.919	-3.854	-3.806	-3.799	-3.482
35%	-1.650	-2.374	-2.624	-2.788	-2.792	-2.998	-3.365	-3.197	-3.301	-3.371	-3.714	-3.633	-3.527	-3.564	-3.262
36%	-1.484	-2.190	-2.447	-2.588	-2.619	-2.812	-3.128	-2.984	-3.082	-3.173	-3.507	-3.388	-3.261	-3.328	-3.013
37%	-1.316	-1.977	-2.249	-2.375	-2.468	-2.599	-2.945	-2.781	-2.851	-2.982	-3.324	-3.177	-3.033	-3.068	-2.767
38%	-1.185	-1.796	-2.041	-2.186	-2.250	-2.400	-2.760	-2.569	-2.673	-2.777	-3.111	-2.957	-2.827	-2.833	-2.559
39%	-1.060	-1.610	-1.843	-2.003	-2.083	-2.225	-2.519	-2.399	-2.509	-2.583	-2.927	-2.720	-2.609	-2.593	-2.319
40%	-0.918	-1.419	-1.638	-1.840	-1.888	-2.043	-2.334	-2.201	-2.286	-2.396	-2.743	-2.512	-2.382	-2.327	-2.129
41%	-0.763	-1.284	-1.504	-1.656	-1.696	-1.859	-2.142	-2.011	-2.089	-2.163	-2.535	-2.314	-2.204	-2.127	-1.898
42%	-0.627	-1.116	-1.332	-1.470	-1.477	-1.689	-1.970	-1.818	-1.891	-1.946	-2.342	-2.102	-2.013	-1.889	-1.652
43%	-0.482	-0.892	-1.176	-1.297	-1.323	-1.509	-1.802	-1.625	-1.694	-1.728	-2.133	-1.854	-1.782	-1.703	-1.453
44%	-0.345	-0.729	-1.016	-1.134	-1.137	-1.353	-1.580	-1.413	-1.479	-1.542	-1.920	-1.670	-1.554	-1.508	-1.231
45%	-0.208	-0.564	-0.813	-0.967	-0.956	-1.162	-1.424	-1.230	-1.297	-1.317	-1.714	-1.437	-1.349	-1.278	-1.051
46%	-0.074	-0.401	-0.658	-0.791	-0.781	-0.995	-1.198	-1.023	-1.125	-1.126	-1.497	-1.224	-1.145	-1.079	-0.852
47%	0.070	-0.247	-0.477	-0.612	-0.598	-0.801	-1.017	-0.856	-0.927	-0.926	-1.294	-1.022	-0.917	-0.866	-0.631
48%	0.207	-0.093	-0.297	-0.462	-0.421	-0.623	-0.819	-0.655	-0.725	-0.750	-1.076	-0.799	-0.717	-0.630	-0.456
49%	0.338	0.070	-0.118	-0.307	-0.230	-0.442	-0.669	-0.501	-0.523	-0.546	-0.868	-0.613	-0.508	-0.449	-0.231
50%	0.477	0.234	0.048	-0.143	-0.072	-0.293	-0.491	-0.295	-0.334	-0.331	-0.638	-0.396	-0.316	-0.230	-0.004
51%	0.618	0.401	0.219	0.017	0.118	-0.098	-0.305	-0.083	-0.155	-0.099	-0.390	-0.164	-0.109	-0.038	0.226
52%	0.747	0.601	0.409	0.183	0.302	0.070	-0.127	0.096	0.057	0.074	-0.182	0.054	0.102	0.140	0.456
53%	0.873	0.815	0.579	0.359	0.462	0.282	0.057	0.302	0.236	0.253	0.033	0.228	0.282	0.387	0.675
54%	1.004	0.992	0.729	0.555	0.641	0.463	0.250	0.510	0.410	0.446	0.227	0.412	0.482	0.620	0.865
55%	1.127	1.172	0.897	0.728	0.786	0.675	0.406	0.684	0.611	0.679	0.415	0.653	0.712	0.827	1.075
56%	1.269	1.317	1.103	0.915	0.979	0.849	0.569	0.860	0.771	0.871	0.605	0.905	0.930	1.004	1.302
57%	1.394	1.492	1.311	1.113	1.149	1.046	0.782	1.054	1.010	1.118	0.792	1.097	1.136	1.202	1.512
58%	1.539	1.683	1.492	1.265	1.346	1.244	0.961	1.245	1.173	1.305	0.986	1.320	1.347	1.458	1.769
59%	1.667	1.841	1.657	1.426	1.525	1.414	1.151	1.404	1.371	1.515	1.223	1.547	1.550	1.704	2.007
60%	1.789	2.035	1.832	1.612	1.747	1.597	1.332	1.608	1.600	1.720	1.443	1.746	1.757	1.942	2.245
61%	1.911	2.208	2.013	1.809	1.907	1.770	1.512	1.818	1.785	1.918	1.694	1.965	1.960	2.178	2.465
62%	2.056	2.386	2.166	1.990	2.126	1.994	1.744	2.020	1.995	2.117	1.905	2.202	2.225	2.408	2.665
63%	2.192	2.611	2.347	2.200	2.320	2.160	1.954	2.200	2.195	2.345	2.117	2.408	2.440	2.643	2.904
64%	2.324	2.789	2.521	2.384	2.486	2.349	2.147	2.383	2.425	2.583	2.345	2.615	2.650	2.851	3.168
65%	2.453	2.975	2.698	2.562	2.665	2.522	2.333	2.570	2.624	2.815	2.608	2.838	2.907	3.088	3.462
66%	2.614	3.134	2.887	2.765	2.849	2.708	2.531	2.751	2.808	2.999	2.818	3.066	3.164	3.286	3.694
67%	2.776	3.284	3.073	2.963	3.033	2.899	2.704	2.934	2.967	3.219	3.032	3.280	3.407	3.523	3.927
68%	2.923	3.488	3.267	3.185	3.214	3.053	2.912	3.149	3.179	3.459	3.238	3.513	3.643	3.765	4.182
69%	3.071	3.695	3.484	3.397	3.411	3.264	3.116	3.364	3.384	3.654	3.481	3.747	3.958	4.037	4.466
70%	3.228	3.866	3.682	3.611	3.643	3.513	3.287	3.537	3.613	3.863	3.702	3.968	4.227	4.257	4.702
71%	3.395	4.085	3.891	3.791	3.854	3.769	3.487	3.740	3.817	4.160	3.997	4.215	4.461	4.502	4.913
72%	3.526	4.281	4.138	3.996	4.052	3.973	3.734	3.957	4.062	4.396	4.210	4.466	4.751	4.752	5.152
73%	3.678	4.485	4.351	4.215	4.288	4.164	3.981	4.145	4.301	4.663	4.436	4.742	4.980	4.995	5.423
74%	3.839	4.712	4.537	4.435	4.507	4.366	4.199	4.367	4.557	4.882	4.707	4.979	5.240	5.271	5.699
75%	4.017	4.912	4.746	4.687	4.719	4.573	4.424	4.554	4.785	5.112	4.927	5.278	5.478	5.546	5.957
76%	4.189	5.135	4.947	4.891	4.937	4.792	4.635	4.793	4.990	5.351	5.183	5.552	5.763	5.806	6.256
77%	4.346	5.369	5.185	5.131	5.198	5.028	4.865	5.015	5.270	5.622	5.503	5.827	6.028	6.042	6.559
78%	4.525	5.618	5.398	5.373	5.378	5.267	5.106	5.290	5.480	5.845	5.773	6.082	6.289	6.331	6.881
79%	4.666	5.865	5.618	5.617	5.620	5.464	5.345	5.554	5.767	6.133	6.047	6.340	6.560	6.654	7.153
80%	4.853	6.091	5.831	5.828	5.911	5.732	5.592	5.801	6.053	6.397	6.416	6.650	6.914	6.998	7.469
81%	5.046	6.413	6.089	6.098	6.156	6.000	5.836	6.061	6.388	6.688	6.655	6.948	7.261	7.338	7.762
82%	5.260	6.667	6.329	6.343	6.453	6.270	6.105	6.321	6.643	6.977	6.964	7.277	7.557	7.645	8.085
83%	5.426	6.911	6.604	6.641	6.704	6.502	6.430	6.556	6.916	7.352	7.267	7.579	7.871	7.980	8.402
84%	5.632	7.152	6.876	6.918	6.959	6.812	6.726	6.944	7.262	7.654	7.599	7.948	8.180	8.361	8.812
85%	5.841	7.463	7.190	7.186	7.264	7.111	7.014	7.250	7.608	7.960	7.904	8.313	8.512	8.701	9.183
86%	6.059	7.779	7.473	7.478	7.530	7.452	7.365	7.550	7.917	8.265	8.249	8.635	8.850	9.073	9.573
87%	6.279	8.044	7.747	7.814	7.873	7.831	7.738	7.911	8.225	8.626	8.618	8.956	9.260	9.453	9.969
88%	6.546	8.418	8.106	8.154	8.208	8.182	8.137	8.243	8.568	8.954	8.968	9.303	9.673	9.923	10.432
89%	6.866	8.778	8.537	8.474	8.525	8.631	8.486	8.547	9.007	9.391	9.399	9.704	10.057	10.298	10.959
90%	7.103	9.155	8.885	8.854	8.977	9.020	8.881	9.006	9.398	9.913	9.858	10.207	10.547	10.769	11.375
91%	7.416	9.540	9.267	9.237	9.383	9.438	9.337	9.375	9.848	10.292	10.227	10.672	11.001	11.208	11.917
92%	7.710	9.980	9.681	9.643	9.836	9.945	9.769	9.880	10.314	10.784	10.708	11.212	11.497	11.781	12.435
93%	8.043	10.464	10.081	10.138	10.369	10.413	10.407	10.382	10.815	11.223	11.195	11.796	12.116	12.342	13.121
94%	8.410	10.970	10.684	10.656	10.803	10.986	10.959	10.946	11.375	11.792	12.004	12.405	12.811	12.996	**13.740**
95%	**8.903**	**11.571**	**11.279**	**11.261**	**11.471**	**11.538**	**11.641**	**11.627**	**12.043**	**12.502**	**12.670**	**13.225**	**13.616**	**13.728**	14.524
96%	9.335	12.188	12.007	11.955	12.087	12.282	12.395	12.377	12.864	13.252	13.432	14.058	14.366	14.773	15.393
97%	9.978	13.013	12.845	12.825	13.065	13.172	13.296	13.211	13.893	14.380	14.380	15.303	15.547	15.929	16.416
98%	10.948	14.131	13.898	13.898	14.185	14.409	14.550	14.482	15.264	15.631	15.755	16.493	16.832	17.452	17.891
99%	12.284	16.137	15.614	15.718	16.124	16.198	16.530	16.329	17.210	17.414	17.580	18.700	19.223	19.754	20.147
100%	19.585	22.913	23.772	25.597	25.982	23.939	24.823	27.144	28.321	32.115	31.786	32.166	31.396	33.710	35.877

Percentile	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
0%	-30.739	-30.278	-32.118	-33.829	-33.954	-32.385	-34.997	-32.738	-35.068	-35.458	-35.362	-34.337	-31.945	-37.261
1%	-20.919	-20.712	-20.520	-20.749	-21.185	-21.337	-21.443	-21.199	-21.604	-21.685	-22.368	-22.920	-22.412	-22.468
2%	-18.431	-18.028	-18.425	-18.363	-18.768	-18.671	-18.790	-18.942	-18.980	-19.173	-19.292	-19.791	-19.608	-19.688
3%	-16.908	-16.548	-16.820	-16.913	-17.179	-17.124	-16.986	-17.068	-17.492	-17.353	-17.179	-17.965	-17.757	-17.906
4%	-15.879	-15.436	-15.692	-15.655	-15.989	-16.071	-15.807	-15.868	-16.055	-16.053	-16.000	-16.568	-16.434	-16.386
5%	-14.914	-14.561	-14.583	-14.640	-14.713	-15.167	-14.810	-14.903	-14.871	-15.006	-15.195	-15.431	-15.318	-15.250
6%	-13.966	-13.740	-13.873	-13.779	-13.862	-14.159	-13.935	-13.952	-13.859	-14.124	-14.270	-14.434	-14.309	-14.341
7%	-13.362	-13.172	-13.049	-13.093	-13.103	-13.403	-13.108	-13.076	-13.079	-13.364	-13.434	-13.471	-13.245	-13.445
8%	-12.822	-12.502	-12.538	-12.463	-12.412	-12.671	-12.490	-12.312	-12.280	-12.699	-12.727	-12.530	-12.341	-12.731
9%	-12.230	-11.993	-11.853	-11.897	-11.820	-11.932	-11.748	-11.682	-11.619	-12.116	-12.026	-11.841	-11.648	-11.952
10%	-11.584	-11.547	-11.308	-11.346	-11.172	-11.374	-11.120	-11.129	-10.899	-11.461	-11.410	-11.176	-10.911	-11.344
11%	-11.058	-10.987	-10.781	-10.814	-10.669	-10.815	-10.507	-10.466	-10.391	-10.897	-10.782	-10.598	-10.358	-10.816
12%	-10.551	-10.516	-10.330	-10.322	-10.247	-10.230	-9.983	-10.002	-9.878	-10.223	-10.203	-10.063	-9.719	-10.223
13%	-10.053	-10.069	-9.886	-9.875	-9.731	-9.800	-9.535	-9.543	-9.417	-9.741	-9.766	-9.482	-9.202	-9.563
14%	-9.697	-9.662	-9.520	-9.435	-9.359	-9.363	-8.985	-9.038	-8.956	-9.252	-9.251	-8.992	-8.779	-8.973
15%	-9.262	-9.279	-9.116	-8.992	-8.985	-8.901	-8.543	-8.648	-8.513	-8.825	-8.768	-8.469	-8.319	-8.473
16%	-8.912	-8.791	-8.783	-8.618	-8.645	-8.470	-8.104	-8.205	-8.087	-8.333	-8.366	-8.102	-7.872	-7.972
17%	-8.457	-8.365	-8.414	-8.233	-8.208	-8.114	-7.699	-7.857	-7.651	-7.870	-7.960	-7.683	-7.394	-7.558
18%	-8.114	-8.053	-8.082	-7.791	-7.852	-7.791	-7.302	-7.432	-7.286	-7.455	-7.562	-7.189	-6.953	-6.998
19%	-7.768	-7.702	-7.756	-7.471	-7.457	-7.354	-6.911	-7.002	-6.868	-7.073	-7.122	-6.860	-6.585	-6.576
20%	-7.409	-7.367	-7.350	-7.093	-7.140	-6.920	-6.621	-6.692	-6.503	-6.678	-6.697	-6.461	-6.158	-6.104
21%	-7.135	-7.015	-7.009	-6.738	-6.785	-6.502	-6.259	-6.365	-6.201	-6.347	-6.363	-6.059	-5.829	-5.747
22%	-6.791	-6.722	-6.677	-6.429	-6.468	-6.144	-5.948	-5.975	-5.809	-5.970	-5.968	-5.666	-5.450	-5.356
23%	-6.528	-6.356	-6.387	-6.122	-6.152	-5.901	-5.664	-5.663	-5.470	-5.699	-5.562	-5.175	-5.125	-4.977
24%	-6.182	-6.033	-6.083	-5.774	-5.806	-5.552	-5.396	-5.321	-5.124	-5.348	-5.236	-4.826	-4.774	-4.598
25%	-5.925	-5.791	-5.808	-5.473	-5.458	-5.264	-5.074	-4.994	-4.807	-5.007	-4.846	-4.492	-4.402	-4.212
26%	-5.673	-5.463	-5.552	-5.173	-5.169	-4.994	-4.796	-4.683	-4.477	-4.717	-4.506	-4.147	-4.103	-3.877
27%	-5.382	-5.204	-5.316	-4.870	-4.866	-4.680	-4.518	-4.340	-4.165	-4.356	-4.180	-3.867	-3.759	-3.583
28%	-5.111	-4.907	-4.963	-4.583	-4.582	-4.446	-4.206	-4.015	-3.836	-4.026	-3.802	-3.570	-3.386	-3.259
29%	-4.859	-4.605	-4.668	-4.288	-4.274	-4.150	-3.883	-3.722	-3.562	-3.711	-3.473	-3.257	-3.060	-2.870
30%	-4.606	-4.354	-4.380	-4.019	-3.953	-3.885	-3.580	-3.401	-3.267	-3.398	-3.136	-2.898	-2.780	-2.534
31%	-4.367	-4.047	-4.073	-3.704	-3.670	-3.595	-3.307	-3.119	-2.955	-3.086	-2.791	-2.613	-2.422	-2.215
32%	-4.136	-3.794	-3.763	-3.423	-3.383	-3.321	-3.023	-2.914	-2.676	-2.773	-2.479	-2.308	-2.145	-1.890
33%	-3.915	-3.546	-3.513	-3.193	-3.137	-3.030	-2.790	-2.659	-2.389	-2.462	-2.210	-1.950	-1.865	-1.558
34%	-3.597	-3.326	-3.241	-2.953	-2.851	-2.732	-2.485	-2.400	-2.127	-2.187	-1.914	-1.679	-1.562	-1.208
35%	-3.286	-3.058	-3.005	-2.709	-2.610	-2.485	-2.218	-2.082	-1.834	-1.828	-1.632	-1.411	-1.259	-0.890
36%	-3.034	-2.799	-2.718	-2.420	-2.405	-2.204	-1.966	-1.831	-1.545	-1.449	-1.324	-1.072	-1.010	-0.614
37%	-2.785	-2.517	-2.468	-2.162	-2.156	-1.948	-1.724	-1.560	-1.291	-1.134	-1.063	-0.764	-0.687	-0.282
38%	-2.558	-2.297	-2.210	-1.925	-1.895	-1.736	-1.445	-1.257	-1.013	-0.831	-0.781	-0.465	-0.385	0.004
39%	-2.343	-2.005	-1.967	-1.651	-1.673	-1.447	-1.169	-0.939	-0.763	-0.544	-0.501	-0.179	-0.016	0.290
40%	-2.106	-1.767	-1.711	-1.367	-1.395	-1.197	-0.938	-0.675	-0.455	-0.291	-0.182	0.115	0.318	0.578
41%	-1.862	-1.543	-1.436	-1.111	-1.181	-0.967	-0.669	-0.433	-0.157	0.015	0.078	0.381	0.572	0.870
42%	-1.634	-1.338	-1.236	-0.854	-0.880	-0.720	-0.402	-0.123	0.153	0.282	0.334	0.681	0.845	1.158
43%	-1.425	-1.104	-1.006	-0.600	-0.672	-0.467	-0.138	0.146	0.414	0.546	0.655	0.906	1.192	1.410
44%	-1.215	-0.852	-0.766	-0.359	-0.408	-0.217	0.104	0.387	0.718	0.810	0.909	1.171	1.459	1.710
45%	-0.924	-0.637	-0.511	-0.155	-0.169	0.045	0.380	0.685	0.962	1.069	1.202	1.526	1.725	1.985
46%	-0.680	-0.385	-0.240	0.110	0.051	0.302	0.599	0.909	1.205	1.320	1.511	1.772	1.984	2.275
47%	-0.442	-0.173	0.022	0.351	0.302	0.544	0.859	1.174	1.440	1.622	1.783	1.989	2.342	2.583
48%	-0.228	0.032	0.246	0.634	0.566	0.800	1.087	1.458	1.686	1.924	2.014	2.283	2.665	2.850
49%	0.026	0.305	0.476	0.858	0.804	1.057	1.342	1.705	1.979	2.230	2.329	2.612	2.928	3.169
50%	0.247	0.548	0.699	1.066	1.039	1.284	1.626	1.957	2.254	2.507	2.677	2.871	3.181	3.458
51%	0.478	0.763	0.938	1.332	1.275	1.506	1.897	2.191	2.533	2.768	3.000	3.129	3.466	3.686
52%	0.716	0.983	1.197	1.574	1.526	1.744	2.178	2.442	2.804	2.997	3.257	3.371	3.705	3.932
53%	0.973	1.215	1.437	1.805	1.771	1.968	2.407	2.691	3.046	3.334	3.581	3.647	3.973	4.206
54%	1.213	1.502	1.700	2.012	2.045	2.231	2.680	2.981	3.301	3.588	3.841	3.960	4.196	4.495
55%	1.453	1.676	1.953	2.262	2.295	2.500	2.930	3.231	3.573	3.769	4.112	4.270	4.463	4.817
56%	1.678	1.900	2.229	2.504	2.528	2.746	3.178	3.506	3.941	4.074	4.380	4.581	4.767	5.095
57%	1.904	2.142	2.440	2.731	2.764	2.982	3.477	3.736	4.207	4.316	4.709	4.818	5.103	5.378
58%	2.138	2.386	2.652	2.941	2.999	3.248	3.720	4.043	4.481	4.600	4.991	5.155	5.408	5.682
59%	2.383	2.657	2.906	3.217	3.236	3.462	4.019	4.317	4.762	4.868	5.241	5.421	5.766	5.981
60%	2.628	2.885	3.131	3.467	3.454	3.766	4.314	4.611	4.991	5.134	5.503	5.746	6.068	6.307
61%	2.868	3.138	3.388	3.677	3.712	4.018	4.574	4.836	5.276	5.405	5.797	5.996	6.373	6.594
62%	3.066	3.400	3.632	3.909	3.967	4.328	4.815	5.056	5.573	5.647	6.082	6.310	6.624	6.918
63%	3.328	3.640	3.885	4.175	4.276	4.608	5.082	5.305	5.811	5.924	6.379	6.651	6.900	7.224
64%	3.565	3.862	4.139	4.427	4.573	4.845	5.358	5.653	6.074	6.201	6.657	6.891	7.154	7.544
65%	3.786	4.124	4.447	4.696	4.848	5.107	5.648	5.948	6.366	6.470	6.938	7.225	7.467	7.786
66%	4.065	4.339	4.674	4.973	5.100	5.385	5.863	6.174	6.678	6.736	7.209	7.509	7.776	8.029
67%	4.300	4.591	4.920	5.253	5.401	5.655	6.143	6.465	6.927	7.032	7.480	7.819	8.098	8.317
68%	4.530	4.854	5.165	5.534	5.687	5.924	6.467	6.776	7.229	7.363	7.755	8.138	8.379	8.641
69%	4.816	5.119	5.425	5.781	5.895	6.182	6.788	7.102	7.489	7.664	8.091	8.402	8.692	8.925
70%	5.028	5.353	5.692	6.069	6.240	6.492	7.044	7.440	7.733	7.914	8.401	8.708	9.086	9.261
71%	5.293	5.606	5.969	6.350	6.559	6.774	7.355	7.751	8.074	8.164	8.755	8.956	9.428	9.574
72%	5.584	5.872	6.210	6.652	6.842	7.054	7.693	7.994	8.356	8.470	9.037	9.291	9.758	9.882
73%	5.921	6.138	6.471	6.859	7.136	7.385	7.932	8.340	8.640	8.770	9.408	9.654	10.101	10.234
74%	6.176	6.408	6.720	7.150	7.387	7.648	8.262	8.651	9.008	9.125	9.743	10.023	10.493	10.595
75%	6.482	6.750	7.028	7.474	7.671	7.932	8.595	9.007	9.382	9.441	10.048	10.366	10.848	10.953
76%	6.771	7.059	7.354	7.843	7.950	8.226	8.940	9.304	9.703	9.807	10.354	10.692	11.240	11.298
77%	7.019	7.337	7.636	8.163	8.254	8.577	9.247	9.630	10.057	10.137	10.734	11.021	11.638	11.645
78%	7.321	7.683	7.963	8.499	8.541	9.032	9.603	9.896	10.496	10.479	11.089	11.365	12.102	12.052
79%	7.649	7.971	8.301	8.809	8.853	9.356	9.994	10.219	10.831	10.859	11.438	11.725	12.423	12.426
80%	7.935	8.369	8.552	9.141	9.143	9.721	10.396	10.596	11.129	11.258	11.806	12.144	12.789	**12.829**
81%	8.271	8.720	8.874	9.468	9.542	10.055	10.777	10.925	11.562	11.637	12.195	12.532	**13.205**	13.256
82%	8.584	9.063	9.215	9.910	9.905	10.382	11.118	11.321	11.913	12.073	12.705	**12.913**	13.651	13.699
83%	8.879	9.455	9.591	10.260	10.323	10.750	11.475	11.752	12.290	12.484	**13.062**	13.331	14.121	14.164
84%	9.245	9.768	9.943	10.694	10.735	11.154	11.896	12.146	12.737	**12.944**	13.526	13.824	14.671	14.642
85%	9.550	10.101	10.284	11.101	11.143	11.497	12.301	12.595	**13.193**	13.442	13.962	14.302	15.085	15.146
86%	9.983	10.387	10.725	11.574	11.578	11.893	12.763	**13.169**	13.614	13.950	14.402	14.728	15.611	15.680
87%	10.391	10.823	11.133	11.971	12.080	12.249	**13.217**	13.671	14.112	14.507	14.882	15.183	16.163	16.166
88%	10.830	11.198	11.706	12.441	12.632	**12.748**	13.756	14.176	14.681	15.002	15.341	15.740	16.602	16.798
89%	11.237	11.708	12.173	12.974	**13.125**	13.270	14.313	14.657	15.193	15.580	15.939	16.288	17.118	17.334
90%	11.778	12.260	12.627	**13.482**	13.659	13.805	14.836	15.329	15.735	16.060	16.597	16.981	17.711	17.939
91%	12.306	12.776	**13.132**	14.063	14.150	14.299	15.358	15.926	16.290	16.571	17.151	17.609	18.427	18.558
92%	12.914	**13.371**	13.668	14.799	14.870	14.958	16.017	16.489	16.936	17.202	17.797	18.290	19.076	19.253
93%	**13.504**	13.954	14.243	15.502	15.653	15.701	16.699	17.137	17.555	17.889	18.549	18.903	19.716	20.063
94%	14.123	14.514	15.128	16.225	16.412	16.505	17.447	17.984	18.225	18.558	19.294	19.626	20.641	20.933
95%	15.055	15.306	15.871	16.904	17.277	17.213	18.247	18.907	19.179	19.451	20.116	20.687	21.542	21.895
96%	15.824	16.242	16.882	17.740	18.086	17.986	19.263	19.818	20.161	20.549	21.217	21.833	22.603	22.935
97%	16.959	17.433	18.077	18.998	19.157	19.247	20.443	21.164	21.281	21.855	22.480	23.058	24.088	24.402
98%	18.618	18.933	19.577	20.515	20.983	20.911	22.045	22.669	22.997	23.697	24.390	24.756	25.783	26.466
99%	21.016	20.892	22.115	22.998	24.005	23.109	24.226	25.113	25.401	26.096	27.122	27.744	28.494	29.391
100%	35.802	32.274	31.762	35.102	37.082	39.192	35.249	38.460	41.281	38.425	41.813	42.803	43.437	42.334



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